Technical Study 32

THE MEDIUM-TERM EMPLOYMENT OUTLOOK: SELECTED SUBSECTORS OF THE ELECTRONICS INDUSTRY

Harvey Schwartz

July 1981

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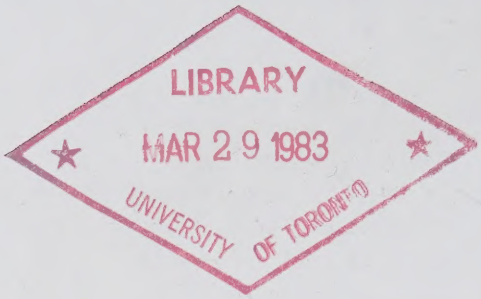

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ABSTRACT

**THE MEDIUM-TERM EMPLOYMENT OUTLOOK:
SELECTED SUBSECTORS OF THE ELECTRONICS INDUSTRY**

Harvey Schwartz

In an industry subject to such rapid technical change and dynamic growth as the electronics industry, traditional approaches to manpower forecasting are inadequate. Simple extrapolations of past requirements will not forecast well for products that are not yet on the market or for industries that are experiencing radical changes in their structure or in their production techniques. Nor will macro models embodying skill coefficients based on dated average industry requirements provide a useful guide to the future. What is required, instead, is a detailed examination of where the industry is going, of what its competitive position is like relative to its international rivals and of how technical change may alter the industry's product mix and production techniques. Based on this intelligence, forecasts can be made of the employment implications and, when compared with estimates of skilled labour availability, the potential skill shortages which could constrain output can be identified.

Such an approach was applied to two subsectors of the electronics industry: a) consumer products and b) computers, peripherals and electronic office machines. From extensive interviews with industry representatives, government officials, and other knowledgeable observers and from secondary sources of information, a consensus view was formed. This permitted some qualitative implications to be derived for employment and some judgements to be made as to whether a shortage of skilled labour could pose a constraint on future expansion.

In consumer electronics, an attempt was made to identify the significant products of the decade. It was concluded that some (video cassette recorders, video cameras and videodisc players) are not likely to be produced here and that others, which are or will be produced here (TV receivers, projection TV, satellite-to-home-antenna systems and microwave ovens), have labour requirements that pose no constraints on output. Judgements about the remaining consumer product examined (home information systems) were difficult since it is not yet clear whether these systems will catch on and, if they do, how quickly the market will develop. Moreover, the important question of whether the Canadian Telidon technology will be accepted in the U.S. market, or whether it will even survive in Canada, cannot yet be answered.

Given the uncertainty, the best that can be done is to state that jobs could be created in the production of hardware for the domestic market and possibly for the export market. Moreover, since these systems are computer based, they will also require software skills. The constraints on the production of the hardware and of the computer software appear to be similar to those for the computer, peripheral and electronic office machines subsector summarized below. The most significant employment opportunities in consumer products, however, do not lie in the production of hardware but in the production of programming and the generation of data bases for home entertainment, education and information systems.

Industry observers expect the market for computers, peripherals and electronic office machines to grow rapidly in the 1980s although there is some disagreement as to how quickly the "office of the future" technology will be implemented. The current constraint on the spread of

computer technology is a critical shortage of software personnel -- programmers, systems analysts and applications analysts. Technical change, in the form of program automation, programmable chips and possibly the introduction of non-procedural languages and voice synthesizer technology, may help mitigate the pressures on the supply of programmers and systems analysts by the late 1980s. But a shortage of applications personnel, people who understand software and the applications to which the computer will be put, will be a continuing difficulty.

In hardware manufacturing, a shortage of technologists and technicians, the personnel who turn the applied research into marketable products, is the current constraint on production rather than design engineers or assembly labour. This is expected to continue as the chip increases the skilled labour and capital content of production and reduces the assembly labour content. Finally, the sheer growth in the use of computer systems, especially small systems, should accentuate the current shortage of maintenance and repair personnel.

The shortage of software personnel is not unique to Canada but applies in all countries pursuing computer-based technology. As this technology spreads many opportunities will arise, and an adequate supply of software personnel could bestow advantages on Canada to supply the domestic and export software markets. It could also provide a competitive edge for domestic hardware producers, and it would be an attractive force for multinational hardware manufacturers. In addition, it would facilitate the spread of computer technology to other industries, increasing their productivity and competitiveness.

The qualitative forecasts in this study could be turned into quantitative forecasts if current skill coefficients were available. Such data could become available from an Ontario Manpower Commission study for the Ontario Task Force on Microelectronics. Yet manpower forecasts will still require substantial intelligence on the industry, and a good deal of this is already being gathered in the many federal and provincial government studies on opportunities in the electronics industry. However, the opportunities are often examined without considering whether the required labour will be available, or better, whether it will be available at the expense of some other opportunity. There is a need, therefore, to bring manpower forecasting into the process so that manpower planning can be used to facilitate the identified opportunities.

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PERSPECTIVES D'EMPLOI À MOYEN TERME: CERTAINS SOUS-SECTEURS DE L'INDUSTRIE ÉLECTRONIQUE

Harvey Schwartz

Dans une industrie marquée, comme l'est celle de l'électronique, par une croissance dynamique et une évolution rapide des techniques, les méthodes classiques de prévision des besoins de main-d'oeuvre ne conviennent guère. De simples extrapolations faites à partir des besoins antérieurs de main-d'oeuvre ne permettent pas d'établir des prévisions sûres lorsqu'il s'agit de la fabrication de produits qui n'ont pas encore atteint le marché, ou de secteurs d'activité qui subissent de profonds changements tant du point de vue de leurs structures que de leurs techniques de production. D'autre part, les modèles macro-économiques qui font usage de coefficients périmés en matière d'effectifs ne sauraient fournir un bon indice de la situation future. Ce qu'il faut plutôt, c'est examiner en détail les orientations que prendra l'industrie, sa position par rapport à ses concurrents internationaux et la façon dont l'évolution des techniques peut modifier la structure de sa production et les techniques employés. À partir de ces informations, des prévisions peuvent être établies quant aux perspectives d'emploi et, en comparant ces dernières aux estimations touchant l'offre de main-d'oeuvre spécialisée, on peut identifier les pénuries éventuelles de travailleurs qui seraient de nature à gêner la production.

Une telle méthode a été appliquée à deux sous-secteurs de l'industrie électronique: celui des biens de consommation et celui des ordinateurs, des périphériques et des machines de bureau électroniques. Des entrevues exhaustives menées auprès de représentants de l'industrie, de fonctionnaires et d'autres observateurs bien renseignés

ainsi qu'auprès d'autres sources d'information secondaires ont permis d'en arriver à un consensus sur la situation de l'industrie. De ces consultations, on a pu dégager certaines constatations qualitatives quant aux perspectives d'emploi et former certaines opinions sur la question de savoir si une pénurie de main-d'oeuvre spécialisée pourrait éventuellement entraver l'expansion de l'industrie.

Dans le secteur des biens de consommation électroniques, on a tenté d'identifier les produits qui marqueront l'activité de l'industrie au cours de la décennie. Il ressort de cet examen que certains biens (dont les magnétoscopes à cassettes, les caméras vidéo et les lecteurs de vidéodisque) ne seront vraisemblablement pas produits au Canada, alors que la production d'autres biens, qui sont déjà fabriqués ici ou le seront à l'avenir (tels les téléviseurs, les téléprojecteurs, les systèmes d'antennes de réception directe par satellite et les fours micro-onde), comporte des besoins de main-d'oeuvre auxquels il est possible de répondre sans entraver la production. Il a été difficile de se prononcer quant aux autres biens de consommation examinés (notamment les systèmes d'information "à domicile"), car il est trop tôt pour savoir si ces systèmes trouveront bon accueil auprès du public et, dans l'affirmative, à quel rythme ce marché se développera. D'ailleurs, reste à savoir - et c'est une question primordiale - si la technologie Télidon réussira à conquérir le marché américain, ou si même elle survivra au Canada.

Vu cette incertitude, on peut tout au plus affirmer que la production de matériel destiné au marché intérieur, et peut-être à celui de l'exportation, pourrait créer des emplois. D'ailleurs, comme les systèmes en question sont

gérés par ordinateur, leur commercialisation mettra également à contribution les talents de spécialistes en logiciel. Les limites imposées à la production de matériel et de logiciel sont, semble-t-il, fort similaires à celles qu'on a notées (et résumées ci-après) dans le sous-secteur des ordinateurs, des périphériques et des machines de bureau électroniques. Cependant, les plus importants débouchés engendrés par l'industrie des biens de consommation découleront non pas de la production de matériel, mais plutôt de la réalisation de programmes et de bases de données destinés à appuyer les systèmes domestiques servant à des fins récréatives et éducatives, ou de systèmes d'information.

Les observateurs dans le domaine s'attendent que le marché des ordinateurs, des périphériques et des machines de bureau électroniques connaisse un essor rapide au cours des années 1980. Toutefois, les opinions diffèrent sur la question de savoir à quel rythme on verra s'implanter la technologie du bureau de l'avenir. La prolifération de la technologie informatique est actuellement freinée par une pénurie critique de spécialistes en logiciel, c'est-à-dire de programmeurs, d'analystes fonctionnels et d'analystes d'applications. Les changements d'ordre technique, comme l'automatisation de la rédaction de programmes, l'emploi de microplaquettes programmables et peut-être même l'introduction d'une technologie axée sur des languages de programmation non techniques et des synthétiseurs de voix, pourraient concourir à réduire, d'ici la fin de la décennie, les pressions qui s'exercent sur l'offre de programmeurs et d'analystes fonctionnels. Toutefois, la pénurie de spécialistes des applications, soit ceux qui comprennent le logiciel et les applications auxquelles doit servir l'ordinateur, continuera de se faire sentir.

Pour ce qui est de la fabrication du matériel, les entraves du point de vue de la production tiennent à la pénurie de technologistes et de techniciens (c'est-à-dire ceux qui transforment les fruits de la recherche en produits marchands) plutôt qu'à un manque d'ingénieurs-concepteurs ou de travailleurs préposés au montage. On prévoit que cette tendance se maintiendra en raison de l'importance accrue des microplaquettes dont la production exige une forte proportion de capital et de main-d'oeuvre spécialisée, mais un faible nombre de travailleurs préposés au montage. Enfin, la popularité croissante des systèmes informatiques, notamment des petits systèmes, contribuera à accentuer la pénurie actuelle de travailleurs spécialisés dans l'entretien et la réparation.

La pénurie de spécialistes en logiciel n'est pas un phénomène propre au Canada: on le retrouve dans tous les pays qui s'intéressent à la technologie informatique. Avec la prolifération de cette technologie, de nombreuses possibilités s'ouvriront dans l'industrie et le fait de disposer d'un effectif suffisant de spécialistes en logiciel pourrait grandement favoriser le Canada en tant que fournisseur de logiciel autant sur le marché intérieur que sur celui de l'exportation. De plus, la disponibilité de telles ressources pourrait avantager les producteurs canadiens de matériel par rapport à leurs concurrents, sans compter qu'elle serait de nature à attirer au Canada les multinationales spécialisées dans la fabrication de matériel. Enfin, elle favoriserait l'extension de la technologie informatique à d'autres secteurs d'activité, ce qui permettrait d'améliorer la productivité et le caractère concurrentiel de ces secteurs.

Pour convertir en prévisions quantitatives les constatations d'ordre qualitatif exposées dans la présente étude, il faudrait disposer de coefficients des effectifs actuels. L'étude réalisée par l'Ontario Manpower Commission, pour le compte du Groupe de travail de l'Ontario sur la microélectronique, pourrait livrer ce genre de renseignements. Il n'en reste pas moins que, pour établir des prévisions relatives à la main-d'oeuvre, il faudra posséder des renseignements exhaustifs sur l'industrie, renseignements qui sont pour la majeure partie, actuellement recueillis dans le cadre des nombreuses études réalisées par les gouvernements fédéral et provinciaux sur les possibilités offertes par l'industrie électronique. Toutefois, ces possibilités sont souvent examinées sans qu'on se demande si la main-d'oeuvre requise sera disponible, ou même s'il ne faudra pas aller chercher des travailleurs dans un autre secteur d'activité. Il est clair, par conséquent, que la prévision de la main-d'oeuvre doit être intégrée au processus global de planification de façon à aider l'industrie, par la planification des effectifs, à tirer parti des possibilités qui se dessinent.

CONTENTS

1. Introduction

Forecasting the manpower requirements of the electronics industry is a hazardous task. There have been few industries that have experienced such rapid technical change or the resulting plethora of new products and new production techniques. Moreover, the industry's structure exhibits all of the characteristics of dynamic growth. Few barriers to entry appear to exist, other than a good idea and a small amount of capital, and new companies seem to arise out of nowhere. Some become substantial international competitors in a relatively short time whereas others, plagued by management's inability to cope with rapid growth, technical change, or competitive pressures, soon disappear.

Technical change is also blurring the traditional boundaries among the subsectors of the industry as computer technology moves into telecommunications, telecommunications technology moves into computers, and both technologies move into office machines, consumer products, and the products of other subsectors. Since the products and production techniques of other industries are becoming electronic as well, it is more and more difficult to distinguish between the electronics industry and other industries.

In such an environment, the traditional approaches to manpower forecasting are clearly inadequate. Simple extrapolations of past requirements will not forecast well for products that do not yet exist or for industries that are experiencing radical changes in structure or in their production techniques. Nor will macro models embodying technical or skill coefficients based on dated average industry requirements provide a useful guide to the future.

What is required, instead, is a thorough understanding of where the industry is going, of what its competitive position is like relative to its rivals in other countries, and of how technical change may alter the product mix and the production techniques of the industry. The task is a difficult one but it is clearly a necessary one if the dynamics of the industry are to be understood and the consequent employment implications derived.

In this paper an attempt is made to apply such an approach to two subsectors of the industry, consumer products, and computers, peripherals and electronic office machines. Based on extensive interviews with industry representatives, government officials, and other knowledgeable observers, an attempt was made to identify the major product innovations of the 1980's. The interviews were supplemented by drawing on secondary sources of information - trade periodicals, business periodicals, technical journals, government reports, and other published material. The same sources were used to try to uncover the competitive environment in which the significant products would compete both domestically and internationally. Finally, the possible technical changes that could affect production were examined if the identified products were likely to be produced in Canada. On the basis of all this information some implications could be derived for employment and some judgments made as to whether a shortage of skilled labour could pose a constraint on future expansion.

Given the uncertainties involved in making judgments for as long a period as ten years, a very large crystal ball was often required. Moreover, the severe time constraints imposed on this

study did not permit the luxury of pursuing many of the issues that arose so that some are treated in a very cursory manner. This is particularly true where the technical questions are quite complex or where government regulatory behaviour has an important bearing on the innovation of a product. Hence the paper should be viewed more as an attempt to set out an approach to the problem of manpower forecasting rather than as a definitive study of the employment implications for the industry over this decade.

2. Consumer Electronics

2.1 Defining the Subsector

The consumer electronics subsector may be defined to include electronic products that are consumed directly by households. While it is possible to define the subsector in general terms, there is great disagreement within the industry as to which products properly belong in this subsector and which are part of other industries even if they are wholly or mostly electronic in content. For example, IT&C defines its consumer products subsector as equivalent to SIC 334 (Manufacturers of Household Radio and Television Receivers) and therefore it includes household radios (including automobile radios), TV sets, record players, and tape recorders and players as part of this subsector.

Most definitions, however, are much broader than the one used by IT&C and typically include some but not necessarily all of the following commodities:

1. antennas and parts; TV, CB, and radio (SIC 315),
2. hifi systems and components (SIC 335),
3. magnetic tape (SIC 399),
4. hand-held calculators (SIC 318),
5. electronic games and toys (SIC 393),
6. electronic watches and clocks (SIC 391),
7. home alarm systems; smoke, gas, and intrusion (SIC 391 and 335),
8. telephone answering devices (SIC 335),
9. electronic musical instruments (SIC 399),
10. microwave ovens (SIC 332), and
11. hearing aids (SIC 391).

2.2 The World Market for Consumer Electronics

Given the wide variety of products involved and the limited time available for this study, it is clearly impossible to deal with the world market in any comprehensive manner. Nevertheless, it would be useful to begin at a very broad level by looking at some recent data on domestic consumption in three major world markets: the United States, Western Europe, and Japan.

Table 2-1 provides such data drawn from the trade periodical Electronics. The data are rough measures of domestic consumption for major consumer electronics products in the three markets for 1979 and 1980, and projections for 1981. Also shown are 1984 projections for the U.S. market alone. Before the data are discussed it would be useful to describe what they represent, or better, appear to represent. The data are based on a survey conducted by Electronics in the three major world markets from September to November, 1980. The U.S. data are for shipments at the factory level from U.S. and foreign producers and include domestic and off-shore products sold under U.S. labels and domestic and foreign labels. The Western Europe data are based on an eleven-country survey (Belgium, Denmark, France, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom, and West Germany) and represent a "concensus" estimate of domestic consumption valued at the point of production for domestic producers and at landed cost for imports. The data were valued in domestic currencies and then converted into U.S. dollars at the exchange rates prevalent in November, 1980. The Japanese data appear to be derived in a similar way, although it is not really stated exactly what they represent. It should also be noted that

TABLE 2-1

Domestic Consumption and Projections of Domestic Consumption of Major Consumer Electronics Products in the United States, Western Europe, and Japan, 1979, 1980, 1981, and 1984
(Millions of U.S. Dollars)

Product	1979				1980				1981				1984
	U.S.	Western Europe	Japan	Total	U.S.	Western Europe	Japan	Total	U.S.	Western Europe	Japan	Total	U.S.
Television Receivers	4,091.3	6,533.7	2,426.4	13,051.4	4,079.0	6,824.7	2,479.0	13,382.7	4,203.0	6,969.5	2,470.7	13,643.2	4,577
Black and White	543.3	742.0	61.2	1,346.5	506.0	700.6	46.0	1,252.6	511.0	641.7	37.0	1,189.7	510
Colour	3,548.0	5,791.7	2,274.3	11,614.0	3,573.0	6,124.1	2,287.5	11,984.6	3,692.0	6,327.8	2,270.1	12,289.9	4,067
T.V./Radio/Recorder Combinations	-	-	90.9	90.9	-	-	145.5	145.5	-	-	163.6	163.6	
Other Video Products													
Home Video Cassette Players/ Recorders	360.0	437.0	415.0	1,212.0	480.0	715.8	591.3	1,787.1	599.3	894.7	790.7	2,284.7	733
Home Video Cameras	43.0	30.1	82.6	155.7	63.5	43.4	149.9	256.8	95.3	53.6	133.6	282.5	160
Home Video Disc Players	6.2	-	-		24.2	-	-		85.7	-	-		400
Home Video Projectors	68.5	-	15.7		80.4	-	61.9		191.3	-	65.7		500
Radios (including Automobile)	956.3	1,392.0	306.4	2,654.7	900.7	1,371.3	270.0	2,542.0	910.4	1,413.1	277.5	2,601.0	1,205
Phonographs and Radio/ Phonographs	725.0	518.2	185.3	1,428.5	700.0	528.7	149.8	1,378.5	735.0	532.4	170.7	1,438.1	720
Radio, Tape Recorders and Players	778.0	648.7	706.8	2,133.2	791.3	697.7	838.9	2,327.9	829.8	724.2	900.9	2,454.9	1,010
Radio/Recorder Combinations	-	661.1	551.8		-	718.3	666.2		-	775.6	736.3		
HiFi Audio Systems	905.0	1,715.4	784.1	3,404.5	926.0	1,914.4	977.5	3,817.9	960.5	2,103.1	1,049.9	4,113.5	1,093
Telephone Answering Devices	88.0	-	15.4		115.0	-	16.3		148.7	-	16.7		250
Electronic Games and Toys	506.4	-	318.9		634.0	-	318.0		762.2	-	334.7		1,131
Calculators, Hand-Held	645.0	399.5	183.9	1,228.4	625.0	410.1	192.6	1,227.7	611.0	416.5	191.6	1,219.1	626
Electronic Watches and Clocks	639.0	512.3	563.4	1,714.7	655.0	579.0	571.5	1,805.5	699.0	647.6	608.9	1,955.5	868
Smoke Detectors	87.5	-	-		98.0	-	-		103.4	-	-		119
Intrusion Alarms	235.0	-	-		255.0	-	-		295.0	-	-		520
Microwave Ovens	1,147.0	177.6	348.5	1,673.1	1,400.0	192.4	373.6	1,966.0	1,612.0	267.8	386.4	2,266.2	2,300
Totals	11,281.2	13,025.6	6,904.2	31,211.0	11,827.1	13,995.8	7,656.5	33,479.4	12,841.6	14,798.1	8,134.3	35,774.0	16,212

Source: Electronics, McGraw-Hill, New York, January 13, 1981.

there are some inconsistencies between the U.S. and the Western European and Japanese data so that not all product categories are comparable. In any case, these data will be used as a rough measure of consumption trends in the major world markets.

2.3 Market Trends in the 1980's

The data in Table 2-1 provide some indication of the likely market trends in the world market of the 1980's. However, of greater interest are the data in Table 2-2 which show the percentage distribution of domestic consumption in the U.S. for 1979 and 1980, and the projected percentage distribution for 1981 and 1984. These data are particularly useful in determining which of the products are mature and have declining market shares and which are new and have increasing market shares. Since Canadian consumption trends tend to follow the U.S. lead, implications for the market trend in Canada during the 1980's may also be derived from these data.

Mature products are ones that are already in widespread use, and demand therefore depends primarily on the replacement of early purchased products, on new uses for these products, and on population growth. While the market for many of these products can still be very large in dollar terms, nevertheless their share of the market should decline in the 1980's. This clearly seems true for radios, radio-phonograph combinations, hand-held calculators, audio tape recorders and players, and hifi audio systems and components, among others.

Some of the expected growth products of the 1980's also show up on the table and they include video cassette recorders and video cameras, videodisc players, projection TV, electronic games and toys, intrusion alarms, and microwave ovens. Since some of these products have implications for employment in Canada and for the trade balance, they are worth exploring in more detail. Also, some

Table 2-2

Percentage Distribution of the Value of Domestic Consumption and Projections of Domestic Consumption of Major Consumer Electronic Products, the United States, 1979, 1980, 1981,and 1984

Product	1979	1980	1981	1984
Television Receivers	36.27	34.49	32.73	28.23
Black and White	4.82	4.28	3.98	3.15
Colour	31.45	30.21	28.75	25.09
Other Video Products	4.23	5.50	7.57	11.06
Home Video Cassette Players/Recorders	3.19	4.06	4.67	4.52
Home Video Cameras	0.38	0.54	0.74	0.99
Home Video Disc Players	0.05	0.20	0.67	2.47
Home Video Projectors	0.61	0.70	1.49	3.08
Radios (including Automobile)	8.48	7.62	7.09	7.43
Phonographs and Radio/Phonographs	6.43	5.92	5.72	4.44
Audio Tape Recorders and Players	6.90	6.69	6.46	6.23
HiFi Audio Systems	8.02	7.83	7.48	6.74
Telephone Answering Devices	0.78	0.97	1.16	1.54
Electronic Games and Toys	4.49	5.36	5.94	6.98
Calculators, Hand-Held	5.72	5.28	4.76	3.86
Electronic Watches and Clocks	5.66	5.54	5.44	5.35
Smoke Detectors	0.78	0.83	0.81	0.73
Intrusion Alarms	2.08	2.16	2.30	3.21
Microwave Ovens	10.17	11.84	12.55	14.19
	100.00	100.00	100.00	100.00

Source: Table 2-1.

potentially significant market trends of the 1980's are not revealed by the data in the table and these include home information systems and satellite-to-home broadcasting and they deserve to be explored as well. Finally, one of the mature products, television receiver sets, is very significant in dollar terms and may not decline in market share as quickly as the data in the table indicate. Hence, it also deserves some comment. In the next section, the likely significant products of the 1980's will be examined to permit some judgments to be made of the impact on the demand for labour in Canada and in particular on the demand for skilled labour.

2.4 Significant Products of the 1980's

2.4.1 Video-Cassette Recorders and Video Cameras

The home video-cassette recorder (VCR) was introduced by Sony in 1976 and there are now three incompatible VCR systems competing on world markets:[1]

1. Sony's Betamax system,
2. the video home system (VHS) developed by the Victor Co. of Japan (JVC), and
3. a system developed by Philips.

However, the Philips system, produced by Philips and Grundig, has been marketed until recently only in Europe.

All VHS and Betamax recorders are produced in Japan and they are marketed worldwide under different brand names. For example, VHS units are sold by JVC, Panasonic, Quasar, Hitachi, Sharp, RCA, General Electric, Magnavox, GTE Sylvania, Curtis Mathes, and under store labels such as J.C. Penney, whereas the Betamax system is sold by Sony, Sanyo, Toshiba, Zenith, and under the Sears store label.

Sales of VCRs have grown rapidly since they were first introduced. In 1976, Japanese production was about 200,000 units[2] but four years later it had reached 4.3 million units.[3] Production in 1981 is expected to exceed colour TV output in Japan and this implies

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1. These are the survivors. Other systems such as the Sanyo and Toshiba V-cord and Matsushita's Quasar VX were withdrawn from the market.
2. "Japanese Tangle in Home-VTR Contest", Electronics, October 14, 1976.
3. Electronics in Japan '80-81, The Electronics Association of Japan, Tokyo, 1980.

at least 9 million units.[1] Moreover, the composition of output has changed since the first units were introduced. The early output consisted entirely of deck units but by 1980 portables accounted for about 25 percent of production and they are expected to account for 30 percent in 1981.[2]

VCR sales are likely to continue to grow strongly in the 1980's despite competition from videodisc players. Portable units and video tape cameras should also increase in popularity, creating difficulties for sales of home movie equipment. The VCRs could have an impact on the sales of reel-to-reel tape recorders as well if pulse-code-modulator adaptors become popular for digital audio recording and playback.

Since Canada is an importer of VCRs, import data provide a good approximation of annual unit sales. In 1978 imports were 21,824 units valued at $15.2 million whereas in 1979 there were 30,113 units valued at $22.2 million.[3] Data for 1980 are not yet available but given the activity at the retail level, it is not unreasonable to assume that unit sales were at least double the 1979 level, or 60,000 units. At average 1979 import prices, this produces an estimated import value of about $45 million. Video tapes are also imported and imports of blank and recorded tapes were $16.8 million in 1978 and $21.1 million in 1979.[4] Preliminary data for

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1. "1981 World Markets Forecast", Electronics, January 13, 1981.
2. Ibid.
3. Statistics Canada, Imports Merchandise Trade Commodity Detail, 1979 (Cat. No. 65-207).
4. Ibid. However, some of these imports are for broadcasting use.

1980 indicate that tape imports could reach $30 million,[1] so that the import value of the total VCR and video tape market in 1980 could be at least $75 million.

While the VCR market in Canada is still in its early stages, it is unlikely that VCRs will be produced here in the 1980's. The technology required to produce VCRs is very sophisticated and the scale necessary to be competitive appears to be quite large. Both of these create significant technical and capital barriers to entry. More importantly, it is unlikely that Japanese producers will move to branch plant production or license producers elsewhere since they seem perfectly capable of satisfying their world market sales from Japan. Therefore, Canada's growing sales of VCRs will be satisfied by imports as will its sales of blank video tape. If an opportunity exists in this market, it is in the production of content for recorded tape including not only programming for home entertainment but also educational, industrial, and commercial programming. The market for VCR programming could be an important one and it is possible for Canadian program producers to supply it along with the other programming markets that will develop in this decade.

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1. Estimated from January to November data in Statistics Canada, Imports by Commodities, November 1980 (Cat. No. 65-007).

2.4.2 Videodiscs[1]

Three incompatible videodisc systems will also be competing in the consumer electronics market of the 1980's:

1. a laser optical system (called laservision) developed by Philips that was introduced by its U.S. subsidiary, Magnavox, in 1978,
2. a grooved capacitance system (capacitance electronic-disc system, or CED) developed by RCA that was introduced in March, 1981, and
3. a grooveless capacitance system (video high-density disc system, or VHD) developed by the Victor Co. of Japan (JVC) and that will be introduced in late 1981.

Each of the systems involves three distinct aspects - the production of the players, the production of the videodiscs, and the production of the programs, or the software for the systems. In all aspects, an impressive lineup of international firms is represented.

For example, the players for the CED system will be produced initially by RCA but they will be marketed by both RCA and Zenith, the two dominant firms in the U.S. television receiver market, and by Sears, J.C. Penney, and Radio Shack. Zenith is expected to offer its own player in 1982 and Sanyo, Toshiba, and Hitachi are also expected to produce players for the U.S. market. The VHD system players are to be produced in Japan by JVC and by Matsushita Electric under its National, Panasonic, and Quaser brand

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1. The material in this section draws heavily on "Videodiscs: A Three-Way Race for a Billion-Dollar Jackpot", Business Week, July 7, 1980.

names. They will also be produced in the U.S. by an unnamed company jointly owned by the Japanese companies and by General Electric, and in Europe by Thorn-EMI. The Philips' laservision players are currently being produced by both Magnavox, for the home market, and by Universal Pioneer (jointly owned by Pioneer Electric of Japan, IBM, and MCA) for the industrial and home markets, with the home players being marketed in the U.S. by Pioneer. Fisher and Advent also plan to market the players in the U.S. under their own labels. Philips intends to produce the players in Europe as well and Sanyo intends to produce them in Japan for the Japanese and European markets.

While there are technical differences between the three systems that affect their performance and market prices (the CED system is the least expensive and versatile whereas the laservision system is the most expensive and versatile), these appear to be of less significance for consumers' acceptance than program availability. Since each of the three systems will have to compete not only with the other systems but also with video tape and pay-TV, which can fulfill similar functions, some observers believe that program quality is the key to success. As a result, the promoters of the three systems have attempted to line up program suppliers to cutoff part of the market for themselves. Thus, RCA not only has access to its own programs (through NBC) but also has agreements with MGM/CBS Home Video (jointly owned by MGM and CBS) and with Beta and Taurus Film in Europe. The discs for RCA's CED system are to be made initially by RCA but CBS should begin production as well later this year. The two other systems have made or are attempting to make

similar arrangements with Philips (tied to MCA) and JVC (tied to Thorn-EMI). Other program providers, such as 20th Century Fox, Columbia Pictures, and ABC, intend to offer discs for all three systems, and the record companies see videodiscs as an important new market for records that combine music and video. As a result, the market for programming is likely to be much more competitive than the player suppliers would like to see.

It is difficult at this stage to predict which of the three systems is likely to dominate the market. The marketing clout of the participants promoting RCA's CED system and the fact that the players are cheaper than the others would appear to bestow an initial advantage on that system. Yet the retail price differences in the U.S. market are not that large. The laservision players being sold by Pioneer have a suggested retail price of $775 whereas the RCA Players have a suggested retail price of about $500. The VHD players are likely to be priced between the other two. Also, the VHD and laservision players provide features such as stop-action, random access, and slow motion capabilities that are likely to be attractive to consumers. Finally, the laservision system has the potential for substantial technical improvement, which appears not to be true for the other mechanical systems, and therefore it is quite possible that it may experience substantial future price reductions. Hence, the Philips system may in fact dominate the market, not only in Europe and Japan where its superior technical performance is likely to be attractive, but also in other markets that are more price sensitive, such as the U.S. and Canada.

The substantial sums invested in the development and marketing of the videodisc technology and the number and the size of participants in the market clearly indicate that substantial consumers sales are expected. One estimate forecasts sales of 5 million players and 200 to 250 million discs in the U.S. by 1990.[1] However, there seems to be some controversy as to how quickly sales will actually rise because the incompatible systems may slow down consumers' acceptance and because of the alternatives of video tape and pay-TV. Moreover, as noted earlier, there is some doubt as to which of the three systems will eventually dominate the home market. The same sort of doubt, however, does not appear to exist with respect to the industrial and educational market. Indeed, it seems clear that the technical versatility of the optical-disc technology will dominate and that the market for videodiscs for industrial training, educational, and product demonstration programs will be very large. Moreover, videodiscs are expected to come into widespread use for document storage and retrieval systems and as an alternative form of data storage in computer processing systems. Disco Vision Inc. (jointly owned by IBM and MCA) is already promoting industrial videodisc players and programming and the company has started to make discs as well. New competition is expected from Sony and from the French company Thomson-CSF.

It is difficult to make judgments about the innovation of videodisc technology for Canada given the uncertainties in the market. The Philips' laservision players are now being imported into Canada from the United States but sales up to this point have

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1. RCA estimate quoted in Business Week, ibid.

been miniscule. The RCA players are not expected to arrive on the Canadian market until late 1981 and they are expected to be priced at about $1000. Given that this price is in the low end of the VCR retail market, the Canadian market for videodisc players may develop slowly, especially since the discs are also expected to be considerably more expensive than in the United States.

If the technology does take off and a significant market develops, then the impact is likely to be on our trade balance rather than on employment in Canada since the players will probably be produced elsewhere. The primary opportunities appear to lie in the production of programming for the discs and in the production of the discs themselves. Given that the market for content and discs could be a substantial one, both possibilities are worth exploring.

2.4.3 Home Information Systems

Two types of home information systems are being promoted as potential major consumer products of the 1980's - teletext and videotex (or viewdata). Teletext is the generic name for a one-way information system that can be broadcast along with an existing TV signal over the vertical blanking interval by a local TV station or by satellite. A decoder is then used to unscramble the signal on the viewer's TV receiver. Cable systems can also transmit teletext on the unused vertical blanking interval of an existing TV signal or over an unused, or blank cable channel dedicated solely to a teletext service.

Videotex, in contrast, is a two-way interactive information system. It could be a stand-alone system or an interconnected system that uses the telephone network or a cable system to transmit the information. A decoder is also used to unscramble the signal and a TV receiver is normally employed as a terminal, but since the signal need not be sent over a TV channel, any display terminal can be used to view the information. The decoders for teletext and videotex are often identical but they use different interfaces depending on the carrier. However, decoders that are dedicated solely to teletext are simpler and considerably cheaper than those designed for both videotex and teletext.

2.4.3.1 Competing Home Information Systems

There are a number of competing teletext and videotex technologies that have been developed and are being actively promoted in different countries. Media attention has tended to focus on the competing national systems developed by Canada, Britain, and France. Yet there are other national systems and a number of corporate or proprietory systems as well. Table 2-3 provides a list of the major national systems and some of the U.S. corporate systems but it is by no means exhaustive. Indeed, a videotex conference to be held in Toronto in May, 1981 is reported to have some 40 competing videotex systems on display.

The Canadian Telidon technology, developed by the Department of Communications, is a method of coding information for display on the viewer's terminal. Telidon uses an alpha-geometric coding scheme that is technically superior to the alpha-mosaic coding scheme used by the British, French, and other competing systems. Alpha-geometric coding permits enhanced alphanumeric text presentation and superior graphics, both of which are important in commercial and educational applications. This coding method is also independent of the transmission characteristics of the communications link and of the user's display terminal. Hence, unlike the alpha-mosaic coding scheme, which is fixed to the current display standards of TV receivers, Telidon is compatible with current high-resolution display terminals and with future high-resolution broadcasting standards. The alpha-geometric coding scheme also permits the transmission of pictures through a pictorial description mode. The technical superiority of the alpha-geometric coding scheme, however,

Table 2-3

Selected Competing Teletext and Videotex Technologies

Country in Which Technology Developed	Teletext	Videotex
Canada	Telidon	Telidon
France	Antiope	Teletel
Germany	-	Bildschirmtext (a version of Prestel)
Japan	Captain	Captain
United Kingdom	Ceefax and Oracle	Prestel
United States	-	Viewtron (AT&T)
		QUBE (Warner Amex Cable)
		MicroNet (CompuServe Corp.)
		The Source (Telecomputing Corp. of America)

comes at a cost since Telidon is a more expensive system than its alpha-mosaic rivals.

Telidon can be used for either teletext or videotex because the decoders are identical for the two home information services. This versatility is allowed for by different interfaces depending on the carrier - broadcast, cable, satellite, telephone copper-wired, or telephone fibre-optics. Again, this versatility comes at a cost since the Telidon decoders are much more expensive than the alpha-mosaic decoders designed specifically for teletext. Indeed, the British already have simple and cheap decoders on the market for their Ceefax and Oracle teletext services.

The question of which of the alternative technologies is likely to dominate is a difficult one to answer at this stage. It seems reasonable to assume that the British, French, and Japanese will use their own technologies and that these technologies will also be adopted by other countries. The major battle ground is now in the United States where display standards for teletext (and videotex, since the two are compatible) have not yet been set by the Federal Communications Commission. Telidon is an active rival in this market but it faces not only the heavily promoted British and French technologies but also a number of "made-in-America" rivals as well.

Industry observers argue that the outcome of the competition is crucial for Telidon because if the United States does not adopt it as its standard then Telidon will not be viable in Canada either. To develop a mass market for home information systems requires cheap decoders and they can only be obtained through large volume production. The Canadian market is not big enough to support the scale

necessary to produce the cheap Telidon decoders required to attract a mass audience. If the United States goes alpha-mosaic then a large body of content will be available in that format and manufacturers will produce decoders to access it. Therefore, Canada will also be forced to go alpha-mosaic because of the availability of cheap decoders and to avoid the costs of incompatible data bases with the United States. Hence, just as Canada cannot have a different television transmission standard from the United States, so it can not have a different information coding scheme.[1]

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1. For the purposes of this paper, the argument has been accepted but it deserves further investigation. Incompatibility is not an uncommon feature of communications systems since countries do use different languages and employ different television transmission standards. While incompatibility imposes an economic cost, it also generates certain social and cultural benefits that may be attractive from a national point of view. Hence, the primary question is whether the economic costs of going it alone are so large that they would effectively prevent Canada from implementing home information systems or whether they simply impose extra costs that might be acceptable given the expected benefits.

2.4.3.2 Innovating Home Information Systems in the United States

The major battle in the United States is not only among the competing technologies but also among the carriers that wish to offer home information systems. The innovation of these systems is in fact being pushed by the regulatory environment as well as the carriers' expectations of future profits. The competition among cable system operators for franchises has led to promises to include interactive videotex among their service packages. However, the cost of wiring or rewiring the cable systems to support the two-way videotex systems is substantial and many operators are seeking to offer cheaper teletext services first.

Some broadcasters are already offering a slow data transmission form of teletext to provide closed captioning in television broadcasts for the hearing-impaired. Broadcasters are also interested in offering rapid data transmission systems not only to protect their advertising revenue but also to maintain their claim over the vertical blanking interval which is being encroached on by the cable systems. Hence, CBS is testing the French Antiope system and actively promoting it before the FCC. ABC and NBC have also shown interest in teletext broadcasting although neither one has declared its choice of technologies. Local broadcasting stations have been involved in field tests as well and one Public Broadcasting Station in Washington, WETA-TV, is running a Telidon teletext test.

Competition is not only taking place between potential teletext carriers but also among potential or actual videotex carriers. AT&T, for example, has been testing its Viewtron

technology in Coral Gables, Fla. and an interactive telephone directory service in Albany, N.Y. Some of the cable operators, and especially Warner Amex Cable, are already offering a videotex service. The Warner Amex QUBE system has been in operation in Columbus, Ohio since 1977 and it is now being extended to Cincinnati, Cleveland, Dallas, and Houston. In addition, there are other competitors such as the Source and the MicroNet computer networks which offer a national videotex service to home computer owners. These networks can also be accessed by simple terminals selling for under $400 such as one offered by Radio Shack and the new RCA VP 3301 terminal.

Despite the rivalries among the promoters of the technologies and the carriers, the question of whether anyone will be watching the services is a contentious one. Indeed, it is still unclear whether the services will be commercially viable and if so, how quickly the market will develop. Moreover, the problem applies equally to the United States and Canada.

At this stage it is difficult to determine whether people will find the applications of the two services attractive enough to be willing to incur the cost of the decoders and any user charges that may apply. This is because people are not yet aware of the applications that will be available so that the promoters cannot determine which of the possible applications may be commercially attractive. There have been many attempts to define the possible applications (see Table 2-4 for a representative list for videotex) and field trials are now being conducted to evaluate user acceptance.

Table 2-4

Representative Videotex Applications

General Application	Specific Application
Information Retrieval	
General	news, weather, traffic, sports timetables advertising price lists
Customized	shopping basket stock price data telephone directory profiled information
Interest Matching	houses, cars, jobs car pools personal services
Commercial Transactions	reservations (restaurants, hotels, transportation, car rentals) ticket purchases catalogue purchases electronic funds transfers
Questionnaires	surveys tests opinion polls
Messaging	greetings
Store and Retrieve	personal messages
Store and Alert	electronic mail
Store and Forward	
Calculations	tax returns loans personal finances operational costs calculated information retrieval
Personal Database	personal diary recipes bibliographic references mailing lists
Computer Games	customer - computer customer - customer

(Table 2-4 concluded on next page)

Table 2-4 (concluded)

General Application	Specific Application
Education	school and university instruction specialized training education for the handicapped language instruction
Softward Distribution for Execution in Terminal	calculations games computer aided instruction

Source: Derived from Costa, J.M., and Chitnis, A.M., "Planning the Videotex Network", Canadian Electronics Engineering, April, 1980.

In the case of teletext, the primary cost to the user will be the cost of the decoder since teletext will be offered as a "free" service. The service will be free in that a good deal of the content will be commercial information such as airline timetables, movie listings, restaurant menus, and other shopping information that will be supported by the advertisers. Hence, the major consideration for the viewer is whether the information is different enough or more convenient than information from other sources such as radio, television broadcasting, and newspapers and whether the content is worth the cost of the decoder.

Field trials indicate that other "free" services, such as advertising-supported teleshopping and electronic banking, appear high on the list of attractive applications for videotex. Applications that involve entertainment, such as electronic games and general information retrieval, also appear to be attractive even though these will involve some user charges. However, field trials can be misleading since the users incur no cost and since their responses are often dictated by the novelty of being part of an experiment.

Even in countries where videotex is already available commercially, user acceptance seems to be a problem. The British have had their Prestel system in operation since 1979 but have only attracted a small number of subscribers. A recent estimate places the number at about 4,000 but only about 500 of these are private homes.[1] However, user charges are high and this may be the primary explanation for the slow development of Prestel.

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1. Mokhoff, N., "A Computer Center for the Homeowner", Spectrum, Sept., 1980.

The French plan to get around the problem of user acceptance by forcing the development of their Teletel videotex technology as part of a drive to achieve an all electronic information society (called Telematique). This is to be done by initially providing free terminals for telephone subscribers. After 1983, the terminal and the telephone will be combined into one instrument. By 1985 France hopes to have four million home videotex terminals that will be able to access telephone directory information (both white and yellow pages), shopping at home services, and electronic funds transfer. The first trial of the system will begin in 1981 in Velizy, a suburb of Paris.

In any case, for the services to be commercially viable, a large audience is required to attract the advertisers, and to attract the audience, cheap decoders are needed. But these are not yet on the market. The cheapest ones appear to be the Radio Shack and RCA terminals intended for the computer information networks and they still sell for close to $400 in the United States. It is possible, once the FCC sets display standards, that TV-set manufacturers will begin to incorporate standardized decoders in new TV sets at a reported additional cost of about $100. If this happens, then a large potential audience could be created because of the bouyance that is expected in the TV-receiver market during the 1980's. Yet the basic question remains as to whether people will use the services even if they do become available.

2.4.3.3 The Market in Canada

Unlike the United States, the innovation of home information systems in Canada is being pushed by government as well as by private expectations of profit. Telidon was developed by the Department of Communications and it and other government agencies have been active in promoting the technology and attempting to innovate it commercially.

The implementation of Telidon in Canada is being guided by a national committee with representatives of the information providers, the hardware manufacturers, the carriers (telephone, cable, and broadcasting), the Consumers Association of Canada, the unions, and, of course, government. There is also an information-provider association called Vispac (the Videotex Information Service Providers Association of Canada) which now includes about 60 members. Vispac will provide the data bases for the Canadian Telidon field trials. Vispac members also intend to have a data bank ready when commercial service begins. In addition the Department of Communications has been promoting Telidon in other countries and it has licensed Infomart Inc. (jointly owned by TorStar Inc. and Southam Inc.) to promote and develop the commercial potential of Telidon. Infomart has a subsidiary, Telidon Videotex Systems Inc., which is active in the U.S. market.

The activity up to this point has involved some small-scale field trials but more are planned for 1981 and 1982. The trials have been mostly videotex systems but a few have also been teletext such as one being conducted by TV Ontario. However,

neither the CBC nor any of the major commercial broadcasters have announced their plans for teletext trials. The first commercial application of Telidon is planned for late 1981. This is a videotex service for agricultural producers in Manitoba similar to the one being tested by the United States Department of Agriculture in Kentucky.

The Telidon field trials in Canada and elsewhere have been inhibited up to this point by the cost of the decoders that now sell for about $1000. To encourage additional field trials, the Department of Communications has recently announced a $27.5 million program which, among other things, is intended to finance the production of 6,000 decoders to be lent to companies engaged in field trials providing that they purchase an equal number.

With increased volumes, decoder costs are expected to fall to the $300 to $500 range but the ultimate goal is to have $100 decoder boards for installation in new TV sets and $250 set top adaptors by early 1983. It is not clear what volumes are required to achieve such cost levels. An estimate cited in one interview suggested that with the use of very large-scale integrated chips, costs would fall steeply at first but become relatively flat at a volume of 200,000 units per year and a cost of $500. The estimate, however, appeared to be a few years old and it is possible that technical changes have occurred that could permit lower per unit costs at much larger volumes. Yet it is not clear what volumes would be required to achieve per unit costs as low as $100 for decoder boards and $250 for set top adaptors.

How fast is the market expected to develop? Table 2-5 shows projected decoder sales and decoders in use for the period 1980 to 1986. The decoder sales for 1980 to 1982 represent those purchased for field trials or provided by the government for this purpose. Hence, it is not until 1983 that user purchases are expected to occur. After 1983, the market is expected to grow rapidly so that by 1986 decoder sales are forecasted to reach 360,000, and 860,000 decoders are expected to be in use.

The first commercial applications are likely to be specific and business-related rather than general and consumer-related. The Manitoba agricultural service is one example but other markets where users are willing to pay for information because it is convenient and timely are also possible. Since specific users are also potential general applications users, a general applications market may develop as more and more specific applications are added. As the audience grows, the market will become attractive for teleshopping and electronic banking and other general purpose applications and this will attract the commercial information providers. Moreover, once the applications are in place and cheap decoders are available, the market is expected to take off. Again, this is projected to begin in 1983.

The expectations of the promoters may be optimistic. Unlike the United States, where home information systems are being pushed by the promises of the cable system operators, no such drive exists in Canada. Hence, the systems will have come into existence on the basis of the operators' expectations of profits. Since most

Table 2-5

Actual and Projected Telidon
Decoder Sales, and Decoders in Use,
1980-1986

(Units)

Year	Decoder Sales	Decoders in Use
1980	1,000	1,000
1981	4,000	5,000
1982	25,000	30,000
1983	70,000	100,000
1984	150,000	250,000
1985	250,000	500,000
1986	360,000	860,000

Source: Infomart Inc.

potential users have a very fuzzy idea of what home information systems are all about, it may take some time before the operators are convinced that the profits are likely to be there and, therefore, before they are willing to undertake the necessary investment. Thus, the period of experimentation could be more prolonged than the promotors expect.

Other problems also have to be resolved before commercial operations can really begin. In the case of videotex one significant question is who will provide the communications links for the system? The cable systems? The telephone companies? Or perhaps both? The telephone network is clearly more extensive than the cable network and therefore can reach more potential users. However, the cable systems now serve about 50 percent of Canadian households and likely include a significant share of the potential market. Cable systems also have an advantage in that they have broad band transmission capabilities which allows for more potential videotex applications than the narrow band transmission capabilities of the telephone network. The telephone companies, however, could offset this by moving more quickly into fibre optics but only at considerable cost. Many of the cable companies also face costly investments to add two-way capability and additional capacity if videotex is to be offered.

A related and more important difficulty is whether the carriers will be content to limit themselves to carriage or whether they will try to act as system operators as well and collect the commercial revenue from the information providers and the user

charges from the viewers. Cable system operators in Canada are not now permitted to accept advertising but they have indicated their desire to do so on many occasions. A recent example occurred at a CRTC public hearing where some cable system operators presented a proposal to offer an advertising-supported real estate service to their subscribers. It is conceivable that the telephone companies may also want to expand their roles beyond that of carriage and become system operators as well.

To some extent similar questions arise in the case of teletext. Again there is the question of who will offer the service? Will it be broadcast-based to protect the revenues of the television stations and, therefore, their ability to produce Canadian programming? Or will it be cable-based? And if it is cable-based, who will operate the service - the cable companies or independent system operators?

Many of these problems do not arise in applications where the user buys the information from the information providers, and the carriers could, in these cases, limit their role to simple carriage. Hence, it is possible to introduce specific applications that are also likely to be business applications without great conflict. When it comes to the general applications, aimed at the mass market, conflict will arise since these applications tend to be advertiser-supported and the question of who collects the revenue will be a troublesome one to sort out.

Overriding all of these considerations is the more fundamental question of whether the U.S. market goes alpha-mosaic or alpha-geometric. If the former is true, then given the generally

held view that Canada cannot go it alone, all of the plans and expectations of the Telidon promoters go out the window.

2.4.3.4 Employment Implications

Given all the uncertainty attached to the innovation of home information systems, the question of whether a shortage of skilled labour will pose a constraint on implementation seems somewhat anticlimactic. Yet some general comments can be made.

The next few years at least can be viewed as a period of experimentation as attempts are made to promote the Telidon technology in Canada, the United States, and elsewhere; to define the market for home information systems; and to sort out the problems of undertaking commercial operations. This will generate some employment in Canada in the production of hardware (user and information providers terminals, videotex exchanges, and possibly service data base processors) and in the production of software (data base contents, and management systems for the data base and for system operation). The suppliers that currently have the capability to produce the hardware (other than computer systems) include Norpak Ltd., Electrohome Ltd., AEL-Microtel Ltd., and Northern Telecom Ltd. Both Infomart Inc. and SED Systems Ltd. have software and systems capabilities. In addition, there are a number of information providers that are currently engaged in generating data bases for the systems.

The impression conveyed in interviews with some of these firms is that the available labour supply is not likely to impose a constraint on the experimental phase. The amount of hardware required is not substantial and can easily be produced with little in the way of additional labour. Moreover, the clerical and

editorial skills required for the production of the content appear to be easily obtainable. Finally, while programming skills and systems analyst skills are in short supply, the firms appear to be able to attract the required personnel because of the "glamour-type" jobs being offered. However, the labour requirements in general are not very large and appear to be easily satisfied by the firms.

Looking further down the road, three-possible outcomes can be identified that have somewhat different employment implications. The most optimistic one is where the United States adopts Telidon as its standard. If this should occur, then jobs could be created in Canada to supply Telidon hardware to the U.S. market. Yet there is no guarantee that the jobs will be there since U.S. firms could also produce the hardware and Canadian firms could open U.S. branch plants to manufacture close to the market just as the Canadian telecommunication companies are already doing. Moreover, other suppliers would also be attracted, especially the Japanese who have demonstrated a capacity to serve large volume consumer markets for electronic products.

A second and less optimistic but more likely case is that the United States goes alpha-geometric but employs a domestic technology that is compatible with the Canadian technology. In this case Telidon would also be viable in Canada and jobs could be generated here to supply some of the hardware for the Canadian market and possibly for export markets if other countries adopt the Canadian technology. The impression conveyed in interviews is that the available labour supply is not likely to impose a significant

constraint in carrying out this case. A lot of the labour required will be relatively low skilled assembly labour but some will be highly skilled technicians and technologists who are likely to be in short supply in the 1980's. Hence, the hardware manufacturers will face the same difficulties that all electronic hardware manufacturers will face in attracting highly skilled labour.

The worst case is where the United States goes alpha-mosaic and Canada is forced to import a good deal of the hardware to support its home information systems. The innovation of these systems will still create a lot of jobs since most of the jobs involved in implementing home information systems are not in the manufacture of hardware but in the production of the data bases and in operating the systems. Moreover, the labour implications for this case apply to the other two as well.

A large share of the labour required will be clerical (about 50 percent according to one interview) and editorial (about 30 percent). Neither of these skills is expected to be in short supply. On the contrary, the employment opportunities are likely to be welcomed since the new jobs will create opportunities for people who have these skills and who might otherwise be engaged in other activities. The remaining requirements (about 20 percent) are for computer-based software skills such as programmers and systems analysts. The employers again expect no difficulty in obtaining these personnel but the increased demand will simply add to the difficulties that other employers will have in attracting labour because of the predicted large growth in computer-based technology in the 1980's.

One final comment before this section is concluded. The innovation of home information systems has received a good deal of attention both within government and in the private sector. Yet no one that I interviewed was aware of any study that had looked at the employment implications of these systems other than some very general forecasts based on crude estimating techniques. While such studies may exist, the people interviewed could not direct me to them and I found this somewhat surprising. The explanation is probably related to the other problems in innovating the systems that were viewed as much more serious and the fact that most observers believed that the labour market would look after their needs. They may in fact be correct but the trends to be discussed in section 3.3 indicate a very tight market for computer software skills in the 1980's.

2.4.4 Satellite-to-Home Broadcasting

Satellite-to-home broadcasting is already occurring in Canada but it is unintended in that the signals being received from Canadian and U.S. satellites are meant for distribution to cable system operators and television broadcasters rather than homes. The home ground stations used to receive the signals are relatively expensive (at least $5,000, and usually more) because the low-powered satellite signals in the 3.7 to 4.2 GHz band require antennas of at least 3 metres in diameter to receive reasonable quality signals. However, it is now technically feasible to transmit high powered signals in the 12 GHz band which can be picked up by small antennas or about one metre[1] in diameter and which are expected to sell for less than $500. The inexpensive reception of satellite signals, therefore, is now possible and this opens up the prospect of a mass or home market for this type of broadcasting.

The major constraints on the introduction of satellite-to-home broadcasting are mostly institutional rather than technical. While a current shortage of 12 GHz satellite channels exists, this is not thought to constitute a major problem in a few years. Of greater concern is the need for an international agreement to allocate frequencies and satellite orbits, and a conference to discuss these matters is to be held in 1983. Also, before broadcasting can begin, regulatory approval and a license must be granted and this is often a very time consuming process.

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1. Various sizes have been suggested: 1.8 metres, 1.2 metres, 1 metre, and sometimes less than 1 metre.

Considerable interest already exists in acquiring licenses for satellite-to-home broadcasting. In a recent hearing on service to remote areas, the CRTC received but rejected a proposal for a direct home service in favour of a proposal by Cancom to provide a more conventional satellite service to cable operators and broadcasters. The U.S. Federal Communications Commission has received many applications for a direct satellite broadcasting service and has agreed to hear its first application. This is a proposal by Satellite Television Services, a subsidiary of Communications Satellite Corp., to offer a three-channel pay-TV service.

Given the shortage of satellite channels and the institutional constraints already mentioned, it is unlikely that a direct satellite-to-home service will begin before 1985 or 1986. Moreover, because of the intense opposition that will be exhibited by the television networks, the individual stations, and the cable system operators, the first Canadian and U.S. licenses are likely to authorize a pay-TV or a commercial service using scrambled signals for areas currently unserved by cable systems or poorly served by existing TV stations. Yet as more satellite channels become available and as these markets become adequately served, the pressure will mount to license other operators who will provide a directly competitive service with the cable operators and the existing broadcasters. The proliferation of services will also make it exceedingly difficult to protect Canadian broadcasters (and viewers) from U.S. programming since it will not be possible to limit the number of unscrambled U.S. signals that Canadian homes can receive.

Every challenge creates its own opportunities and satellite-to-home broadcasting is no exception. The increased number of channels offered by the satellite station operators will create a strong demand for programming and Canadian program producers could help fill this demand. It should also create a large market for home satellite antenna systems and its accompanying electronics, and for home descramblers. Moreover, this market will be worldwide since many countries are interested in employing the technology.

At present, Canada does appear to have some technical advantage in this area based on its research in 14/12 GHz transmission and reception and on the development and production of satellite ground stations. Thus it is possible that Canadian firms could be competitive in both the domestic and export markets. While it is difficult at this stage to determine who the major Canadian producers might be, some current producers that could fall into this category include:

SED Systems Ltd., Saskatoon, Sask. (electronics),

Electrohome Ltd., Kitchener, Ont. (electronics),

Triple Crown Electronics Ltd., Rexdale, Ont. (electronics),

Microcom Systems Ltd., Agincourt, Ont. (descramblers),

Andrew Antenna Co. Ltd., Whitby, Ont. (antennas),

Jerrold Division of General Instruments of Canada Ltd., Toronto, Ont. (antennas), and

Miller Communications Systems Ltd., Kanata, Ont., (satellite ground stations).

2.4.5 Television Sets and Projection TV

2.4.5.1 Market Trends in the 1980's

The product innovations (VCRs, videodisc players, and teletext and videotex) and the broadcasting innovation (direct satellite-to-home transmission) rely on the home television set as either a terminal or a receiver. It therefore seems reasonable to assume that such innovations are likely to stimulate television receiver sales during the 1980's.

Recent experience in the U.S. seems to indicate that this is already happening. Unit sales of colour TV sets, after having slumped badly in the mid-1970's, have rebounded sharply to reach record levels in 1978 and again in 1980 when 10.2 million units were sold. The increased sales are in part related to the replacement demand for sets bought in the 1960's and in part to the demand for small portable units as extra home sets. However, the rapid growth of VCR sales has also had an effect as consumers seek earlier replacement to get better quality pictures. Indeed, in a recent article in Business Week, Sony is quoted as stating that every four to five VCR sales leads to the purchase of one new TV receiver.[1]

Driven by the new product innovations, market forecasters expect U.S. colour set sales to rise sharply to 12-14 million and possibly to as many as 15 million units by 1985.[2] Moreover, the

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1. "TV: A Growth Industry", Business Week, February 28, 1981.

2. Quoted in Business Week, ibid.

composition of demand is expected to change as projection TV sales grow at the expense of the larger 26" TV sets and the 14" and smaller portable units increase their share of the market at the expense of the 20" sets.[1] Following recent trends, the units sold are also expected to be more sophisticated, with remote control and multi-channel cable tuners becoming common features.

The increasing use of the home TV set as a terminal could also lead to two other significant changes in the market of the 1980's. The first involves the decomposition of the TV set into components, with the TV monitor, the tuner, the speakers, and the stand sold separately along with other "add-ons" such as a VCR recorder-player (without a tuner), a videodisc player, a cable system tuner, and a teletext - videotex decoder. Sony is already selling its "Profeel" line of component TV in Japan and it is reported to account for nearly 20 percent of Sony's TV sales.[2] A second change is the possible introduction of high resolution TV monitors for VCRs, videodiscs, and teletext and videotex as well as the possible introduction of digital-transmission high resolution broadcasting. Both of these changes would cause the home TV set of the late 1980's to be very different from what consumers know today.[3]

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1. Canadian size designations are used rather than those used in the U.S.
2. Business Week, op. cit.
3. To add a "science fiction" touch as well, it is possible that 3-D TV may be perfected and innovated by the late 1980's.

2.4.5.2 The Canadian Industry

Canadian production consists of colour TV receivers -- no black and white sets are produced -- manufactured by six producers:

1. Sanyo Canada Ltd. in Montreal,
2. Hitachi Sales Corporation of Canada Ltd. in Montreal,
3. RCA Ltd. in Prescott, Ont.,
4. Panasonic Industries Canada Ltd. (Matsushita Electric of Canada Ltd.) in Toronto,
5. Electrohome Ltd. in Kitchener, and
6. Webcor (a new entrant) in Kingsville, Ont.

The companies are engaged in the final assembly of TV receivers using imported chassis, picture tubes from the RCA plant in Midland, Ont., and cabinets that are mostly domestic but involve an increasing share of imports. The current structure of production arose out of the difficulties that the industry experienced in the 1970's from intense import competition.

In the early 1970's, the Canadian industry consisted of about 10 mostly U.S. branch plant producers that had been enticed into the market by the tariff.[1] The industry and its linked

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1. It is somehwat difficult to determine from published sources which firms actually manufactured TV sets. However, based on data in Statistics Canada, Manufacturers of Household Radio and Television Receivers (Cat. No. 43-205) and Scott's Industrial Directory, the following appeared to have been engaged in manufacturing in 1974: Canadian Admiral Ltd., Canadian General Electric Ltd., Electrohome Ltd., Fleetwood Corp., Motorola Canada Ltd., Panasonic Industries Ltd., Philco-Ford of Canada Ltd., Philips Electronics Industries Ltd., Quasar Electronics Canada Ltd., and RCA Ltd.

supplying firms were engaged in all aspects of production- components, picture tubes, chassis, cabinets, and final assembly. Yet component and chassis production are very labour intensive activities and this bestowed a cost advantage on Japanese producers at that time. The appreciation of the Canadian dollar in the early 1970's along with the labour cost advantage led to a rapid growth of lower priced and often better quality imports from Japan,which at first consisted of the smaller sized sets (under 14"), and then later, the more popular 20" models as well. However, the problem of severe import competition was not unique to Canada since the same trend was evident in both the U.S. and in Western Europe.

The increased import competition lead to a restructuring of the industry in the U.S. and Canada. This came about as marginal producers left the market and as other companies attempted to satisfy some or all of their domestic sales either by contracting for units in Japan and in other countries or by setting up production facilities in low-labour-cost countries such as Korea, Singapore, Taiwan, and Mexico. Moreover, some of the Japanese companies also began to move into North America by setting up new final assembly facilities or by buying up the facilities of some of the faltering companies.

By 1976 about one-third of all colour sets sold in the United States were made in Japan,whereas in Canada imports satisfied about half of domestic consumption compared with about 25 percent five years earlier. Given the threat to the survival of the industry,governments in both countries introduced programs to protect the remaining

firms and jobs. In the U.S. this took the form of the Orderly Market Agreements which were introduced in 1977 and involved voluntary quotas first on imports from Japan and later from other countries.

In Canada, the response was the more complicated TV Duty Remission Program of 1977, designed to rationalize the activities of the remaining producers and hence to rationalize the industry itself. This was to be done by encouraging existing producers to either specialize in the larger sized sets or to phase out production and move off to more competitive products. Increased protection was provided by extending the 15 percent duty to the end of 1981 and by withdrawing the lower General Preferential and British Preferential rates on larger sized sets until the end of 1980. Producers were then eligible for the remission of duty on their imports if they increased production over a base period or if they switched to more competitive products.

Given that the tariff-protected Canadian producers had relatively small production runs by international standards, it was hoped that fewer firms and longer and more specialized runs would allow the remaining producers to achieve some of the scale economies that foreign producers seemed to possess. Yet it is not clear that scale was really the major problem since U.S. and European producers, who had much longer production runs than Canadian producers, were also having trouble competing with imports. Rather, the major problem was that the lower labour costs in Japan and in other low-labour-cost countries permitted their producers to operate on lower cost curves. Indeed, by the late 1970's the Japanese were also facing difficulties

competing with low-labour-cost producers because of rising wage rates and the appreciation of the Yen.

By 1978 the production of chassis parts and picture tube parts had disappeared in Canada and only one firm was left producing chassis. Thus, changes were introduced into the program in 1979 to recognize the new reality. This involved the remission of duty on original equipment chassis and components to firms assembling TV sets and increased protection in the form of the withdrawal of the General Perferential and the British Preferential tariffs on all colour sets until the end of 1981.

Since 1979, production in Canada has increased significantly at the expense of imported sets. Part of the explanation appears to be the duty remission on chassis, which permits free entry of the labour intensive part of production, and the increased tariff protection on the final sets.[1] However, most of the explanation is likely related to the substantial fall in the value of the Canadian dollar which turned final assembly into a profitable operation. Some export activity to the U.S. market has also occurred, partly because of special situations and partly because of the increased competitiveness of the assembly producers and because the U.S. still imposes a tariff on chassis. Thus Matsushita Electric of Canada exports sets to the U.S. from its Toronto plant apparently because of production difficulties in its U.S. subsidiary. Also, Electrohome, which purchases its chassis from JVC, exports some finished sets to

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1. There also appears to be a small transport cost and financing cost advantage to assembling in Canada as opposed to shipping the complete set from Japan.

the U.S. under the JVC brand because the latter company has no production facilities in the U.S. However, of greater interest is the new Webcor plant which intends to produce private label brands for the U.S. market.

The industry in 1981 is more prosperous than it has been for some time. Yet it is also different than it was in the past, with fewer firms, longer production runs, and simple assembly production involving low skill labour. It is possible that the industry will continue to drive out imports of finished sets in the rest of the 1980's, but whether it can do this depends on the continuation of protection and on favourable exchange rates for the Canadian dollar.

The TV Duty Remission Program is scheduled to end on December 31, 1981. However, it is very likely that it will be reintroduced in some revised form but with lower levels of protection. Indeed, the tariff on imported sets is scheduled to decline in equal annual amounts from the 15 percent rate of today to 7-1/2 percent on January 1, 1987. Moreover, it also is likely that the Canadian dollar will move up over this period from its current low level. Both of these should erode some of the current advantages enjoyed by the industry.

2.4.5.3 Implications for Employment

The trends of the 1980's can be viewed as both unfavourable and favourable for TV receiver production in Canada. The expected changing mix of set sales during the 1980's will likely take place more slowly in Canada than in the U.S. Projection TV is much more expensive in Canada than in the U.S. (about $3,500 in Canada and $2,000 in the U.S.) and this should slow its acceptance as a consumers' product of the 1980's. At present there is only one Canadian producer of projection TV, Electrohome, which makes sets for sale in Canada and chassis for Advent in the U.S. Electrohome's sales to Canadian consumers have been minuscule up to this point but sales are expected to grow and, if they do, it is likely that other firms will begin to assemble them in Canada and import them from other countries. This should lead to some displacement of sales of larger TV sets (the 26" size), which for the most part are produced here. The increased share of smaller sized units could also lead to more imports and less domestic production of the 20" size sets which now account for about half of Canadian sales. While some small set production takes place in Canada, Canadian producers appear to be less competitive in these units than in the large units even with tariff protection and the low value of the Canadian dollar. As these advantages decline in the 1980's, imports should grow and Canadian production decline.

The changing mix of set sales, by itself, would be expected to lead to more imports and less Canadian production, yet other trends could offset this. First, technological changes are occurring

that could significantly reduce the labour content of the TV receiver. Second, and more importantly, the disaggregation of the TV set into component TV could lead to a large increase in the demand for the simpler TV monitors for use in other activities than as television receivers. It is clearly possible for Canadian producers to assemble such less labour-intensive units and to do it cheaply enough and in such volume as to permit production to be competitive with units produced elsewhere even with a lower tariff and a higher Canadian dollar.

Therefore, there are a number of outcomes that argue for either an increasing share of the Canadian market or a declining share relative to today's production levels. Yet whatever happens, one thing seems clear - increased production will not be constrained by a shortage of skilled labour nor will reduced production free up skilled labour for alternative uses. This is because little if any skilled labour is likely to be required by the industry in the 1980's.

Apart from the assembly of TV receivers, the only other significant segment of the industry is the RCA picture tube plant in Midland, Ontario. At present about half of the plant's output is sold to TV assemblers in Canada with the rest exported to the U.S. and Western Europe. The RCA plant appears to be competitive on international markets so that it is possible that other markets could be found for the plant's output if Canadian TV set assembly declines because of increased import competition in the 1980's. However, since the plant is just one of a number of such plants

owned by RCA in different countries, its export markets are always vulnerable to increased protectionism elsewhere. Offsetting this is possible development of alternative markets for colour picture tubes in Canada in data display units and TV monitors and in commercial applications such as electronic games. Hence it is quite possible for the plant's output to grow even if the demand declines for picture tubes for TV sets in Canada or elsewhere. Whatever the outcome, the implications for the employment of skilled labour do not appear to be significant since the plant is not a major employer of skilled labour.

2.4.6 Microwave Ovens

Only brief comments will be made about one other significant consumer product of the 1980's, microwave ovens.

Table 2-6 provides estimates of unit sales of major appliances in Canada for 1980 and forecasts for the years 1981 to 1986 prepared by the Canadian Appliance Manufacturers Association. The Canadian data confirm the trends noted earlier for the U.S. and for other countries on the growth of microwave oven sales in the 1980's. Indeed, among all the major appliances, only microwave ovens shows significant growth, with forecasted sales for 1986 being 235 percent above 1980 unit sales.

At present three firms assemble microwave ovens in Canada:

1. Canadian Appliance Manufacturing Co. Ltd., which makes a number of major brands such as Litton-Moffat and General Electric as well as private label brands.
2. Canadian Admiral Ltd., which makes its own label as well as private label brands, and
3. Enterprise Foundary Ltd., which makes it own "Enterprise" brand.

The three Canadian assemblers apparently have about one-third[1] of the market, with the rest being supplied by imports, mostly from Japan. However, the Canadian producers are final assemblers, with most of the components being imported from the United States. Thus, little Canadian content is involved other than relatively low skilled assembly line labour.

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1. A rough estimate provided by ITC.

TABLE 2-6

Estimated Units Sales of Major Appliances in
Canada for 1980 and Forecasted Sales for 1981 to 1986
(OOO's of Units)

Product	1980	1981	1982	1983	1984	1985	1986
Refrigerators	542	525	540	555	567	575	580
Freezers	340	340	340	345	345	350	350
Electric Ranges	430	420	430	445	456	460	460
Microwave Ovens	147	185	225	265	295	320	345
Gas Ranges	30	30	35	35	35	35	35
Washers	534	530	540	550	560	565	575
Dryers	388	387	397	407	412	417	422
Dishwashers	308	300	315	330	345	355	365
Air Conditioners	130	128	133	137	142	146	150
Total Sales	2,849	2,845	2,955	3,069	3,157	3,223	3,282

Source: Canadian Appliance Manufacturers Association.

The growth in the Canadian market in the 1980's is not likely to change this situation very much. Since there seems to be a small advantage to assembling in Canada based on the tariff and on transportation costs, assembling operations may grow as the market grows. Little skilled labour is involved and its supply will not create a constraint on expansion. Moreover, the large import content in the Canadian-assembled units along with the completed units imported from other countries means that the growth in demand has more serious implications for our trade balance than it does for employment in the 1980's.

3. Computers, Peripherals, and Office Equipment

3.1 Defining the Subsector

The subsector includes electronic hardware used in the processing of data (computers and peripherals) and electronic office equipment. Many of these products are produced by establishments assigned to SIC 318 (Office and Store Machinery Manufacturers), and IT&C uses this SIC industry to approximate the subsector. However, SIC 318 also includes mechanical and electromechanical office products such as adding machines, duplicating machines and typewriters; store products, such as coin-operated vending machines, and scales and balances; and other products such as computer process control equipment, which are really industrial products. Moreover, a number of important products that properly belong in this subsector are assigned to other SIC industries such as CRT terminals and teleprinters (SIC 335), and copying machines and microfilm equipment (SIC 391). Finally, a number of products that belong in the subsector do not appear in the latest published Standard Industrial Classification Manual[1] and it is not clear to what industries they would be assigned if they were produced in Canada. Given the way that the industry is defined by Statistics Canada, the official published statistics[2] tend to be of little use in determining trends in the value of shipments and employment.

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1. Dominion Bureau of Statistics, Standard Industrial Classification Manual, Revised 1970, (Cat. No. 12-501E).

2. Statistics Canada, Office and Store Machinery Manufacturers (Cat. No. 42-216).

3.2 The World Market

Data from the trade periodical Electronics are again used to provide rough measures of domestic consumption by product in this subsector for three major world markets - the United States, Western Europe, and Japan. Table 3-1 shows detailed product data for domestic consumption for 1979 and 1980, and projections for 1981 for the three major markets as well as 1984 projections for the United States. The data are derived in the same manner as those for consumer electronics products in Table 2-1 and therefore suffer from many of the same problems. However, in this subsector the problem of comparability of the Western European and Japanese data with the United States data is more severe since the data for the two former markets are much less complete. As a result, only data for major product categories are shown in the table for Western Europe and Japan. Yet, since the major product categories appear to be defined somewhat differently in some cases and since estimates for some products are not available for Western Europe and Japan, little significance can really be attached to any major product category comparisons or to the totals for each of the major product categories and each year's totals for the three markets. Indeed, only rough order-of-magnitude comparisons are possible for each of the markets separately. This being the case, the subsequent discussion will deal only with the more complete and consistent data for the United States.

Table 3-1

Domestic Consumption and Projections of Domestic Consumption of Data Processing Systems, Peripherals and Office Equipment for the United States, Western Europe, and Japan, 1979, 1980, 1981, and 1984

(Millions of U.S. Dollars)

Product	1979				1980				1981				1984
	U.S.	Western Europe	Japan	Total	U.S.	Western Europe	Japan	Total	U.S.	Western Europe	Japan	Total	U.S.
Data Processing Systems (1)	13,755.9	9,589.4	3,916.0	27,261.3	15,530.7	10,775.7	4,306.9	30,613.3	18,091.7	12,210.6	4,735.7	35,038.0	29,678
Desktop computers	675.0				945.0				1,262.0				3,000
Small (less than $0.1 million)	1,650.0				1,996.0				2,415.0				4,350
Medium ($0.1 to $1 million)	3,360.0				3,746.0				4,289.0				6,025
Large (over $1 million)	6,863.0				7,343.0				8,223.0				12,506
OEM Minicomputers	998.0				1,232.0				1,540.0				3,000
OEM Microcomputers	209.9				268.7				362.7				797
Memory Systems	718.2	88.6	189.6	996.4	759.0	100.3	215.5	1,074.8	863.8	110.5	242.5	1,216.8	1,320
Data-Storage Subsystems	2,353.1	-	926.1	3,279.2	2,803.8	-	1,143.6	3,947.4	3,392.7	-	1,352.1	4,744.8	5,881
Disk pack	839.0				869.0				908.1				992
Fixed-disk	525.0				656.0				819.7				1,598
Combination fixed/ cartridge disk	400.0				500.0				675.0				1,166
Flexible-disk	227.0				306.0				413.1				1,129
Reel-type magnetic tape	318.0				395.0				481.9				833
Cassette and cartridge magnetic tape	44.1				77.8				94.9				163
Input/Output Peripherals	2,543.3	693.5	658.5	3,895.3	2,895.4	779.8	777.0	4,452.2	3,364.3	868.2	908.4	5,140.9	5,453
Card-read/punch	103.0				93.0				80.0				50
Printers	1,714.3				2,002.5				2,341.3				3,963

(Table 3-1 continued on next page)

(1) Does not include process control computers.

Table 3-1 (Continued)

Product	1979 U.S.	1979 Western Europe	1979 Japan	1979 Total	1980 U.S.	1980 Western Europe	1980 Japan	1980 Total	1981 U.S.	1981 Western Europe	1981 Japan	1981 Total	1984 U.S.
Computer output microfilm	185.0				208.0				238.0				362
Optical character and mark readers	378.0				403.0				478.6				802
Magnetic character and mark readers	19.0				18.0				17.1				14
Electromechanical plotters	99.0				121.0				154.0				198
Digitizers	16.0				18.9				24.3				34
Paper-tape devices	29.0				31.0				31.0				30
Key Entry	275.3	-	-	275.3	256.6	-	-	256.6	241.9	-	-	241.9	203
Data Terminals	1,810.9	1,391.3	1,043.3	4,245.5	2,225.8	1,680.8	1,201.1	5,107.7	2,776.1	1,964.6	1,404.9	6,145.6	5,507
Teleprinter	305.3				379.5				454.0				725
CRT intelligent	595.0				780.0				1,029.6				2,533
CRT other	683.0				797.0				970.0				1,575
Graphics terminals	180.1				225.3				282.5				641
Remote batch and job entry	47.5				44.0				40.0				33
Source Data-Collection Equipment	1,335.0	419.2	192.5	1,946.7	1,533.0	468.1	226.6	2,227.7	1,749.8	516.6	253.0	2,519.4	2,586
Point-of-sale systems	419.0				465.0				525.5				738
Banking systems	234.0				268.0				298.6				413
Industrial data-collection systems	93.0				110.0				130.3				217
Other specialized terminal	589.0				690.0				795.4				1,218
Subtotal	22,791.7	12,182.0	6,926.0	41,899.7	26,004.3	13,804.7	7,870.7	47,679.7	30,480.3	15,670.5	8,896.6	55,047.4	50,628

(Table 3-1 concluded on next page)

Table 3-1 (Concluded)

Product	1979				1980				1981				1984
	U.S.	Western Europe	Japan	Total	U.S.	Western Europe	Japan	Total	U.S.	Western Europe	Japan	Total	U.S.
Office Equipment	3,846.0	3,031.2	461.9	7,339.1	4,729.5	3,286.2	495.6	8,511.3	5,471.3	3,541.9	524.0	9,537.2	8,694
Nonconsumers calculators	298.0				358.0				408.5				903
Word processing	1,090.0				1,398.0				1,705.6				3,022
Dictation	263.0				302.5				310.0				454
Copying	1,850.0				2,257.0				2,573.0				3,600
Fascimile transmission	48.0				59.0				71.0				124
Typesetting	297.0				355.0				403.2				591
Total	26,637.7	15,213.2	7,387.9	49,238.8	30,733.8	17,090.9	8,366.3	56,191.0	35,951.6	19,212.4	9,420.6	64,584.6	59,322

Source: Electronics, McGraw-Hill, New York, January 13, 1981.

3.3 The Market in the 1980's

3.3.1 Product Market Trends

Before the market trends are examined, it would be useful to put the subsector into perspective relative to the rest of the industry. Table 3.2, also drawn from data in Electronics, shows the various product categories produced by the industry and the estimated or projected shares of U.S. consumption. The data show that the data-processing, peripherals, and office machines subsector clearly dominates the industry with 31.07% of total consumption in 1979 and that this is expected to rise to 37.68% by 1984. Yet the true significance of the subsector is in fact understated by the data because the products of some subsectors are embodied in the value of consumption of others, and hence the data involve a good deal of double counting. This can be remedied to some extent by removing the values for components and semiconductors from the total. When this is done, the share for data-processing, peripherals, and office machines rises sharply to 37.31%, 38.25%, 39.51%, and 45.50% for 1979, 1980, 1981, and 1984, respectively.

The data in the table also show that the subsectors' share of projected consumption is expected to grow quickly over the period. In dollar terms, projected U.S. consumption of data-processing, peripherals, and office machine hardware is expected to more than double, from $30.7 billion in 1980 to $59.3 billion in 1984. This contrasts with the more modest growth expected for consumer electronics of 37% over the same period. Hence the subsector is expected to be one of the most dynamic parts of one of the most dynamic industries in the U.S. economy over the next four years.

Table 3-2

Domestic Consumption and Projections of Domestic Consumption of Electronic Products for the United States, 1979 to 1981, and 1984

(Millions of dollars)

Product Category	1979		1980		1981		1984	
	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
Components	9,225.5	10.76	10,094.0	10.43	10,924.4	9.99	14,438	9.17
Semiconductors	5,036.9	5.88	6,326.3	6.54	7,436.9	6.80	12,704	8.07
Test, Measuring, and Analytical Instruments	3,213.3	3.75	3,611.0	3.73	4,068.2	3.72	6,011	3.82
Data-Processing Systems, Peripherals, and Office Machines	26,637.7	31.07	30,738.8	31.76	35,951.6	32.87	59,322	37.68
Communications Equipment	4,158.2	4.85	4,716.3	4.87	5,346.0	4.89	7,532	4.78
Industrial Electronic Equipment	2,413.4	2.82	2,823.5	2.92	3,259.4	2.98	5,387	3.42
Power Supplies, Noncaptive	390.6	0.46	435.8	0.45	480.4	0.44	580	0.37
Medical Equipment	1,979.8	2.31	2,221.8	2.30	2,453.5	2.24	3,670	2.33
Lasers and Related Equipment	105.1	0.12	128.2	0.13	158.8	0.15	233	0.15
Automotive Electronics	304.3	0.35	409.2	0.42	517.2	0.47	1,029	0.65
Federal Government Electronics	20,419.0	23.82	22,850.0	23.61	25,307.0	23.14	29,653	18.83
Consumer Electronics	11,848.8	13.82	12,429.1	12.84	13,459.6	12.31	16,896	10.73
Total	85,732.6	100.0	96,784.0	100.0	109,363.0	100.0	157,455	100.0

Source: Electronics, McGraw-Hill, New York, January 13, 1981.

Table 3-3

Percentage Distribution of the Value of Domestic Consumption and Projections of Domestic Consumption for Data Processing Systems, Peripherals, and Office Equipment, the United States, 1979, 1980, 1981,and 1984

Product	1979	1980	1981	1984
Data Processing Systems	51.64	50.53	50.32	50.03
Desktop computers	2.53	3.07	3.51	5.06
Small (less than $0.1 million)	6.19	6.49	6.72	7.33
Medium ($0.1 to $1 million)	12.61	12.19	11.93	10.16
Large (over $1 million)	25.76	23.89	22.87	21.08
OEM minicomputers	3.75	4.01	4.28	5.06
OEM microcomputers	0.79	0.87	1.01	1.34
Memory Systems	2.70	2.47	2.40	2.23
Data-Storage Subsystems	8.83	9.12	9.44	9.91
Disk pack	3.15	2.83	2.53	1.67
Fixed-disk	1.97	2.13	2.28	2.69
Combination fixed/cartridge disk	1.50	1.63	1.88	1.97
Flexible-disk	0.85	1.00	1.15	1.90
Reel-type magnetic tape	1.19	1.29	1.34	1.40
Cassette and cartridge magnetic tape	0.17	0.25	0.26	0.27
Input/Output Peripherals	9.55	9.42	9.36	9.19
Card-read/punch	0.39	0.30	0.22	0.08
Printers	6.44	6.52	6.51	6.68
Computer output microfilm	0.69	0.68	0.66	0.61
Optical character and mark reader	1.42	1.31	1.33	1.35
Magnetic character and mark reader	0.07	0.06	0.05	0.02
Electromechanical plotters	0.37	0.39	0.43	0.33
Digitizers	0.06	0.06	0.07	0.06
Paper-tape devices	0.11	0.10	0.09	0.05
Key Entry	1.03	0.83	0.67	0.34

(Table 3-3 concluded on next page)

Table 3-3 (Concluded)

Product	1979	1980	1981	1984
Data Terminals	6.80	7.24	7.72	9.28
Teleprinter	1.15	1.23	1.26	1.22
CRT intelligent	2.23	2.54	2.86	4.27
CRT other	2.56	2.59	2.70	2.66
Graphic terminals	0.68	0.73	0.79	1.08
Remote batch and job entry	0.18	0.14	0.11	0.06
Source Data-Collection Equipment	5.01	4.99	4.87	4.36
Point-of-sale systems	1.57	1.51	1.46	1.24
Banking systems	0.88	0.87	0.83	0.70
Industrial data-collection systems	0.35	0.36	0.36	0.37
Other specialized terminals	2.21	2.25	2.21	2.05
Subtotal	85.56	84.61	84.78	85.34
Office Equipment	14.44	15.39	15.22	14.66
Nonconsumers calculators	1.12	1.16	1.14	1.52
Word processing	4.09	4.55	4.74	5.09
Dictation	0.99	0.98	0.86	0.77
Copying	6.95	7.34	7.16	6.07
Fascimile transmission	0.18	0.19	0.20	0.21
Typesetting	1.11	1.16	1.12	1.00
Total	100.00	100.00	100.00	100.00

Source: Table 3-1

Some products are expected to experience growth rates that are above the average for the subsector. These "rapidly growing" products can be readily identified from the data in Table 3-3, which shows the percentage distribution of the value of U.S. consumption for the years 1979 to 1981, and 1984. In data processing systems, it is the small end of the market that is expected to show the most rapid rates of growth with desktop computers, small systems (less than $100,000), and the minis and micros all increasing their market shares at the expense of the large and medium sized systems. Consistent with these expectations are the above average growth rates forecasted for other products, such as fixed-disk and flexible (floppy) disk data storage systems, and CRT intelligent terminals. Among the office machines, it is word processing equipment that is expected to show the most rapid growth in sales.

There are many marketing studies that show similar expectations but carry the forecasts further into the future. Table 3-4 summarizes four examples of such studies, one for the United States and three for Canada. The four forecasts are presented without further comment other than to note that they all embody relatively similar views about the course of technical change and the rapidity in which the market will change over the forecast period. Yet there is considerable controversy as to what in fact may occur over the rest of the decade, and this is what will be considered in the following parts of this section.

Table 3-4

Forecasts of Units in Place (Stock) of Selected Computer, Peripheral, and Electronic Office Machine Hardware, the United States and Canada

	Commodity (units)	Base Year	Forecast Years
(a)	Predicasts Inc.	United States	
		1978	1990
	General Purpose Computers	58,000	80,000
	Microcomputers (except Small Business Computers)	275,000	3,200,000
	Small Business Computers	73,000	1,850,000
	Teleprinters	475,000	1,200,000
	Display Terminals	805,000	3,600,000
	Intelligent Terminals	345,000	5,000,000
	Other Data Terminals	55,000	300,000
(b)	William G. Hutchinson and Co. Ltd.	Canada	
		1979	1985
	Desktop Computers	4,000	100,000
	Minicomputers and General Purpose Computers	15,000	50,000
	Computer Terminals	100,000	300,000
	Communicating Word Processors	750	20,000
(c)	R.W. Hough and Associates Ltd.	Canada	
		1978	1985
	Computers	18,000	150,000
	Date Terminals	250,000	700,000
	Telex, TWX, and Other Message Terminals	56,000	70,000
	Word Processing		
	Noncommunicating	18,000	65,000
	Communicating	1,000	10,000
	Facsimile Terminals	8,000	28,000
	Photocopiers	300,000	450,000

(Table 3-4 concluded on next page)

Table 3-4 (concluded)

Commodity (units)	Base Year	Forecast Years	
(d) Alphatext Inc.		Canada	
		1985	1990
Microprocessor Work Stations	-	250,000	1,000,000

Source:

(a) Quoted in Braden, John H.C., "Office Occupations Statistics Research Papers", Statistical Information Services Division, Communications Economics Branch, Dept. of Communications, October, 1980.

(b) Financial Post, March 8, 1980.

(c) R.W. Hough and Associates Ltd., "Office Automation Equipment: The Present Base and Future Prospects to 1985", prepared for the Communications Economics Branch, Dept. of Communications.

(d) Financial Post, March 8, 1980.

3.3.2 The Computer Hardware Market

The nature of the computer industry has been fundamentally altered by the development of the microprocessor. The microprocessor is based on chip technology, which involves placing densely packed electronic components on a thin wafer of silicon to produce an integrated circuit. A microprocessor is simply a chip with a high degree of integration - that is, it combines a number of functions. The first 1K chip was introduced about ten years ago by Intel Inc. and it has been followed every few years by the 4K, the 8K, the 16K, and the 32K chip. The latest version, the 64K chip, became commercially available in late 1980.

The significance of chip technology for the computer is that it has permitted increased speed of computation, increased data handling capacity, and increased reliability, all of which have dramatically driven down the real cost of computing power. To add to this, the intense competition among chip producers has caused chip prices to fall significantly shortly after new chips are introduced. For example, the 16K RAM was introduced in 1976 at a price of about $40.00 [1] but by the end of 1980 it was selling for about $2.50 in the United States and for less than $2.00 in Japan.[2] The 32K-E - ROM chip started at about $100 in early 1980 and was down to about $12 in late 1980.[3] The new 64K RAM chip was expected to sell for about $40 in 1981 and to be down to about $25 by 1984, but now it is projected to sell for half of the latter amount.[4]

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1. Electronics, Jan.6, 1977. Based on estimated 1976 volume (50,000) and sales ($2 million).
2. Electronics, Jan. 13, 1981.
3. Ibid.
4. Ibid.

The 1980's will see a continuation of these trends. Technical optimists note that the number of transistors that can be placed on a chip more than doubled each year during the 1970's and reached 70,000 in 1980. They expect the trend to continue, which means that by the mid-1980's we will have chips with 1 million transistors and by 1990, chips with 10 million transistors. However, the technical difficulties of developing more complex chips appear to be rising at each stage but even if technology does not pose a significant barrier,costs may. The cost of producing each new chip has risen greatly and intense competition has caused the returns to disappear rapidly. This process could clearly slow down the rate of innovation.

The chips of the 1980's are, then, likely to become increasingly dense as more components and more functions are incorporated into them. Hence, we will get continued increases in the speed, capacity,and reliability of computers and a continuation in the falling cost of computer power. It is also possible that the way computers operate, its architecture, may change as the decade wears on and it becomes possible to move away from the Von Neuman-type architecture that characterizes the computers of today. Such a change opens up the possibility of mind-boggling increases in computer performance. Indeed, one estimate by Martin Cooper of Motorola Inc.[1] suggests that such a change could produce computers of the 1990's with 1 million times greater power than those of the early 1970's.

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1. Cooper, Martin, "Electronics Technologies in the 80's", address to National Electronics Conference of the Electrical and Electronic Manufacturers Association of Canada, Banff, Alberta, June 4, 1980.

The implications of these changes for the computer hardware market seem relatively straightforward and are consistent with the forecasts made by many market research firms. Moreover, they are simply an extension of what has already been observed over the last few years. Technical change and intense competition have combined to produce the small, cheap microcomputer, conventionally defined as a system selling for under $10,000. It is this segment of the hardware market that has experienced the most rapid growth in volume in the last few years and there is every reason to believe that this will continue to be true over the rest of the decade.

When the first micros were introduced, the vendors viewed them as being personal computers,particularly attractive for the home market. Yet hobbyists have not been the chief buyers of these systems. Instead, they have been purchased by small business as small business computer systems, by large business as engineering and management tools, by professionals for accounting, engineering, and business consulting purposes, and by educational institutions as teaching aids.

The rapid growth in sales of the micros and the uses to which they have been put clearly shows that there is a good deal of price elasticity in the small end of the market. Many of the purchasers are new computer users,whereas others are existing users purchasing additional stand-alone systems for specific applications or simply replacing larger, older systems with the smaller, cheaper, and equally capable micros. As price continues to fall and capability grows, sales volume should grow rapidly. It is even possible that the falling price could eventually lead to a significant home

market especially as computer literacy spreads and the machines become attractive for home learning, record keeping, and entertainment. However, since there are alternatives which can provide the same applications, any forecasts about the development of a home market are risky.

In any case, it is the small end of the market that will grow significantly in the 1980's and to some extent this will be at the expense of somewhat larger and more expensive machines. Yet sales of large mainframe systems (defined as selling for over $1 million), while less buoyant than in the past, will continue to grow, and in value terms this end of the market will still dominate. Mainframes will not be displaced by smaller systems since large institutions (government and universities), large business, and the computer service bureaus will continue to require machines that have large volumes of storage and that are capable of large-scale repetitive processing. The mainframes will also be used in process control applications and they are also expected to be used in the office of the future as centralized record storage systems to be accessed by remote dumb or smart terminals or by intelligent work stations, depending on how one views the office of the future as evolving.

Given what has already been said, it seems clear that the market for peripherals will also be buoyant during the 1980's. Technical change will again have a significant effect on the types of products produced but the time constraints imposed on this study do not permit a detailed examination of how this market may evolve other than to note that some of the expected trends are captured in the data in Tables 3-3 and 3-4.

3.3.3 The Market for Software

In contrast to the rapid decline in computer hardware costs that has been experienced and will continue into the 1980's, the cost of software has been rising, so that software now accounts for the largest share of computer user costs. Software production is a very labour intensive activity and there has been little improvement in productivity. The increased use of the computer, therefore, has meant a corresponding increase in the demand for software personnel - programmers, systems analysts, and applications analysts. There appears to be a critical shortage of such personnel today and most industry observers argue it is this personnel shortage, and especially of applications personnel, that is the major constraint on the spread of computer-based technology.

A number of compatible technical changes may help ease this constraint in the 1980's. One is the expansion in program automation by using computers to help write software. A second is the continued development of programmable chips that combine software and hardware and reduce the need for separate systems software. Two other less likely changes have also been suggested and they could have dramatic effects on software costs. The first is the long-awaited introduction of nonprocedural languages being developed by hardware vendors. This would not only reduce the need for skilled programmers but would also permit people with applications skills but little in the way of programming skills to produce applications software. The second involves the use of voice synthesizer technology and related programming capabilities to permit computers to respond to simple voice instruction and allow novices

to operate the machines. All of these changes would mean that the current critical bottleneck caused by a shortage of programmers, systems analysts, and applications analysts might be eased as the decade proceeds. They would also encourage even more use of computer technology as both hardware and software costs decline in real terms.

Despite these changes, the sheer growth in the use of computers in the 1980's will generate a strong demand for software that will be satisfied by the users themselves and by purchases from hardware vendors and independent software houses. Given the rapid growth expected in the small end of the computer market, sales of purchased software, especially off-the-shelf applications packages, are likely to be particularly strong. Sales of customized applications software and systems software are also likely to grow substantially since larger systems users often find it cheaper to buy out rather than produce all the software for themselves.

Two marketing studies, one for the United States and one for Canada, can be cited to illustrate the expected trends. The U.S. study, by Input Inc.,[1] is concerned with how the market for standard, or off-the-shelf packages, and customized software is likely to evolve to 1985. Estimated 1980 U.S. sales of standard and customized software were about equal at somewhat over $2 billion each. By 1985, standardized software sales are expected to rise to about $8 billion whereas customized sales are expected to reach a more modest $5 billion.

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1. Business Week, September 1, 1980.

The Canadian study, by Evans Research Corp., is more comprehensive in that it provides forecasts for hardware, data processing, and purchased software revenue for the period up to 1990. The forecasts, recorded in Table 3-5, clearly show that the purchased software market is expected to grow much more rapidly than the other two. Compared with 1979, forecast revenue is up 2.8 times for hardware, 3.0 times for data processing, and 3.6 times for purchased software. The changes are more dramatic when the 1990 forecasts are compared with 1979 since hardware revenue is up 6.6 times, data processing revenue is up 8.2 times, and purchased software revenue is up by over 10.5 times. Moreover, it is the off-the-shelf applications packages that are expected to drive the purchased software market during this period.

Whether one believes such forecasts or not, it is clear that the purchased software market will be a buoyant one in the 1980's. The more contentious issues are whether the market will be supplied primarily by domestic producers or by imports and whether it will be dominated by the hardware vendors or the independent software houses.

Little information is available on Canadian trade in purchased software. Software is not subject to duty although the tapes and the other media on which it is stored are dutiable. However, the general impression conveyed in interviews with industry observers is that foreign competition is not a serious problem. This is particularly true for the rapidly growing small business applications market because of the extra costs incurred by foreign

Table 3-5
Evans Research Forecasts of Computer
Hardware, Processing, and Software Revenue
(Millions of Dollars)

Revenue Source	Base Year	Forecast years	
	1979	1985	1990
Computer Hardware	1,837	5,085	12,136
Sales, lease, rental	1,689	4,676	11,158
Maintenance and repair	148	409	978
Processing	697	2,115	5,718
Software	197	704	2,065
Applications packages	43	279	1,039
Systems packages	34	161	491
Systems development	120	264	535
Miscellaneous	66	130	205
Total Revenue	2,797	8,034	20,121

Source: Evans Research Corp., The EDP Guide, Vol.II.

software vendors in rewriting their packages to include Canadian tax provisions. While this provides a competitive advantage to Canadian software vendors, it also limits their ability to compete in foreign markets for exactly the same reason. However, Canadian software houses appear to be competitive on foreign markets for other types of software which implies that they are also competitive on the Canadian market. Yet the issue of the trade in software requires a good deal more attention than can be directed to it by the limited time available for this study and that seems to have been directed to it by others as well.

The somewhat related question of whether the predominantly multinational hardware vendors or the mostly Canadian-owned software houses will dominate the market is also difficult to answer. Given that software production is very labour intensive and still more of an art than a manufacturing process, hardware vendors appear to possess no particular advantage over software houses in producing software.

Hence, some industry observers have argued that hardware vendors will still participate in the software market, but the increased emphasis on applications will cause them to concentrate on what they can do best and to sell their hardware as original equipment to software houses who will in turn supply the software along with the hardware to the ultimate buyer. Such a split is likely to be most pronounced in the small end of the market. Indeed, for very small business, retail stores are already selling hardware and off-the-shelf software and this trend is expected to continue.

For larger business, the software houses are expected to become the major suppliers of both off-the-shelf packages and the customized software required for more specialized applications.

The major problem with this view is that the hardware vendors are not likely to ignore the revenue potential from the growing market for software. Moreover, while they may not have any production advantage in software they likely do have a marketing advantage, especially to larger business that already purchases its hardware from these vendors. Some hardware vendors have also argued that the quality of the software will more and more determine hardware sales and that the hardware vendors will therefore have to become aggressive software marketers to sell their hardware. All of this implies that the hardware vendors could become much more active in the market for purchased software.

Given these very different points of view, it is difficult to evaluate how the Canadian market for software may evolve over the 1980's. Yet no matter whether the major suppliers are the hardware vendors or the software houses, there is still likely to be a substantial Canadian content in the market. This is true in part because of the competitive advantage in the production of small business packages and the fact that this market is expected to account for a significant share of total sales. It also arises because other countries are suffering from the same types of labour shortages as Canada and this could constrain the ability to produce software elsewhere to serve the Canadian market. Finally, local firms seem to have an advantage in marketing customized software

because the ease of contact makes it easier and cheaper to serve the buyers' needs. The prognosis, therefore, is an optimistic one especially if our own labour shortages do not pose a significant constraint on the ability to supply the growing domestic market.

3.3.4 Computers and Office Machines: The Office of the Future

The development of the microprocessor has had a profound effect not only on the computer industry but also on the office machine and telecommunications industries. Indeed, this technical change has turned the formerly complementary products manufactured by these three industries into competitive ones.

Up until recently, the three industries were based on very different technologies; the products of the computer industry depended on advanced electronic technology whereas those of the office machine and telecommunications industries depended on either mechanical or electromechanical technologies. Moreover, the products were designed to perform very different functions in the office. The information processing products of the computer industries were intended for large-scale,repetitive-type data processing whereas office machines were intended for the processing of written communications and simple nonrepetitive data processing. The telecommunications industry, in contrast, produced communications terminals and, along with the other information carriers such as the post office and the courier services, provided the communications links for the information processing computers and office machines.

The development of the microprocessor has significantly altered these relationships. In the computer industry, the microprocessor has not only dramatically driven down the cost of computing power but it has also led to the development of the microcomputer. Electronic technology has spread to the office machinery industry as well,with the electronic calculator replacing the mechanical and electromechanical adding machine and calculator, the word processor replacing the mechanical and electromechanical typewriter, and the microcomputer replacing the electromechanical accounting machine. As computer technology continues to move into office machines, the computer and the office machine will become indistinguishable and this forms the basis of the work station for the office of the future.

The telecommunications industry has also become computerized and the industry's terminals can now be viewed as peripherals for a computerized network. Moreover, both computers and computerized office machines can communicate with each other through intra- and inter-office communications networks.

The merging of technologies and functions of the three industries' products has meant that it has become increasingly difficult to distinguish among them. The computer industry now produces machines that can perform office functions and can communicate with each other. The office machine industry produces machines with intelligence and that are able to communicate. Finally, the telecommunications industry offers communications terminals that have intelligence and can perform office functions.

To add to the already obvious areas of conflict, the use of satellite technology permits the computer and office machine industries to operate external communications networks in direct competition with the telecommunications industry.

At this stage it is not yet clear what the office of the future will look like, how fast it will be accepted, or who the major suppliers of the systems will be. While there is considerable controversy about these issues, there appears to be some agreement about certain features of the office of the future. The office can be viewed as an information receiving, processing, storing, analyzing, and transmitting unit and the major thrust of the office of the future is to automate these functions.

As suggested earlier, the automation process involves combining computer, telecommunications,and office machine technology in the form of the communicating, multi-function work station along with its supporting equipment such as the intelligent copier. The communicating, multi-function work station could be viewed as a linear descendent of the communicating word processor and hence it continues the evolutionary development of office automation. Yet

it is intended to do much more than just process words since the software embodied in the work station will permit it to perform a number of office functions such as accounting, personnel management, engineering, graphics and other types of information processing and analysis. Moreover, because it can communicate, it can draw on software packages embodied in other work stations to enhance its capabilities. Its communicating ability also permits it to send, receive, and store messages electronically so that it can serve as an intra-office electronic mail system and, by connecting it to a digital network, as an inter-office electronic mail system. Finally, it will also be able to enter and retrieve information from central data banks in host computers. The electronic entry, storage, and retrieval of data is designed to automate file management but paper will not disappear from the office of the future. Indeed, it is clearly part of it in the form of intelligent printers and copiers that are intended for the production and distribution of documents.

In large offices, it is expected that there will be many of these work stations. Branch offices will have their own work stations connected with those in the central office and to the central data storage system. Smaller offices will have similar but less sophisticated systems that are connected to other offices via a common carrier network.

The rapidity with which the office will be automated is not dependent on the availability of the technology since the technology for the most part is already available and some manufacturers are now marketing their first generation of work stations. Rather, the speed of adoption depends on other issues, and in particular on user acceptance, on the cost of implementing the systems, and on the compatability of vendor-designed systems with user needs.

It is relatively easy for management to automate some office tasks and especially those repetitive tasks carried out by low-skill personnel, such as document preparation, document processing, and file management. The use of word processing

machines is an example of just such an application and it has led to increased productivity and to an increased output of paper in the office as well. Yet implementing the new technology is not really a matter of determining how existing jobs can be automated but rather of defining the problems faced by a company and determining how the new technology can be used to help solve these problems. The solutions will change the nature of the work done and the jobs that people perform.

The complexity of implementation should by itself cause companies to move slowly in making the changes. It might also be expected that there will be a good deal of resistance on the part of workers, including managers, who fear that their jobs or positions in the company will be threatened or who believe that they will be unable to cope with the required changes.

One of the key features of the new technology is the enhanced access to information — managers by themselves, or through their support staffs, should be able to obtain information when they need it and in the form that they need it. At present, the form and timing of the information flow in centralized data processing systems is determined by the systems personnel. Hence, a radical shift will be required in the way that most company data processing systems operate to provide the increased access,and some observers have expressed concern about the possible difficulties of unlocking the data files. An additional but related problem is that of controlling the flow of information so that access is open to those who require particular types of information but not to others. While increased accessibility is desired to enhance decision making, open access is often viewed as undesirable and this again could make companies move slowly until this problem is sorted out.

The cost of actually implementing the systems will also be significant even for large companies since it will involve not only the cost of acquiring the hardware and related software but also the cost of redefining the work relationships within the

office. Therefore, many companies may be reluctant to move unless they are firmly convinced that the promised productivity gains will actually be realized. However, even in this case the response may be slow because of the risk of acquiring and adjusting to systems that may become technically obsolete in a few years.

A final and related factor that could slow down the acceptance of the technology is that systems being marketed over the next few years will be vendor-determined and therefore they may not be compatible with user needs. One would normally expect a period of experimentation to take place as the more technologically responsive firms adopt and modify the systems to better suit their own and other users'needs. As the productivity gains become more obvious and as vendors begin to produce systems that are more closely matched to user needs, user acceptance should grow. How long it will take for this process to sort itself out is not easy to predict but some observers have suggested that it may be at least five years and likely longer before it becomes clear which products and vendors will dominate the industry.

3.4 Canadian Production, Imports,and Exports

The suppliers of computers, peripherals,and electronic office machines can be conveniently divided into the suppliers of general purpose hardware and of customized hardware. The general purpose suppliers to the Canadian market are mostly U.S.-owned multinationals but include some domestically owned firms as well. The customized suppliers, in contrast, tend to be small Canadian-owned firms.

Canadian consumption appears to be heavily satisfied by imports. This is in part because a number of important suppliers do not manufacture in Canada but operate branch sales and service offices for products produced elsewhere, mostly in the United States. Moreover, many of the foreign-owned multinationals that do manufacture here have rationalized their production. Hence, most of what they produce is exported and their domestic sales tend to be satisfied by imports. The Canadian-owned general purpose suppliers and the customized suppliers also tend to specialize in what they produce and export a large share of their output.

Table 3-6 lists the manufacturers of general purpose hardware in Canada along with their country of ownership, their plant locations, and the type of products they manufacture. These 12 companies account for the bulk of the output, employment,and exports of the industry but one, IBM, clearly dominates in all three and in market share as well. All the firms except one could be described as being rationalized in the sense that they either produce specialized products for both the domestic and export markets or

Table 3-6

Manufacturers of General Purpose Computer Hardware and Electronic Office Machines

Company	Ownership	Plant Location	Products
AES Data Ltd.	Can.	Montreal, Que. Mississauga, Ont.	Stand-alone word processors, business systems, data entry, terminals
Bell and Howell Ltd.	U.S.	Toronto, Ont.	Microfilm equipment
Burroughs Business Machines Ltd.	U.S.	Winnipeg, Man.	Disc drives
Consolidated Computers Inc. (CCI)	Can.	Ottawa, Ont.	Small business systems, data entry, terminals
Control Data Canada Ltd. (Computing Devices Co. Ltd.)	U.S.	Mississauga, Ont. Ottawa, Ont.	Mainframe computers, minicomputers
Digitial Equipment of Canada Ltd. (DEC)	U.S.	Ottawa, Ont.	Minicomputers, microcomputers, computer back panels, custom products
IBM Canada Ltd.	U.S.	North York, Ont. Bromont, Que.	Display stations, printers, data entry, computer module circuit assemblies, card transport units
Micom Inc.	Netherlands	Montreal, Que.	Stand-alone word processors, business systems
NCR Canada Ltd.	U.S.	Waterloo, Ont.	Proof-encoding machines for banking industry
Perkin-Elmer Data Systems of Canada Ltd.	U.S.	Mississauga, Ont.	Minicomputers

(Table 3-6 concluded on next page)

Table 3-6 (Concluded)

Company	Owner-ship	Plant Location	Products
Sperry Rand Canada Ltd.	U.S.	Dorval, Que. Winnipeg, Man.	Power supply units
Xerox of Canada Ltd.	U.S.	Mississauga, Ont.	Photocopy machines, sorters

Source: Dept. of Industry, Trade and Commerce, Canada in the World of Electronics, 5th edition, March, 1980; Dept. of Industry, Trade and Commerce, unpublished papers; Electronics and Communications, Epic 80, Electronics Procurement Index for Canada, Southam Business Publications; Computer Data, Canadian Data Processing Directory, 1980 and 1981, Maclean-Hunter Ltd; Evans Research Corp., The EDP Guide, Vol. II; and Scott's Industrial Directory.

components for assembly plants located in other countries, especially the United States. The one exception appears to be Bell and Howell, which operates a small assembly plant for the domestic market.

While it is relatively easy to identify the general purpose manufacturers, identifying the customized manufacturers is a more difficult task. Published industry directories tend to provide little guidance in this matter since companies that are hardware distributors or software houses are often listed as manufacturers. Moreover, some small firms that are actually engaged in manufacturing tend to be overlooked or are classified incorrectly. Perhaps a more important reason is that the start-up rates and mortality rates are high, indicating that entry is not that difficult and that the competitive pressures are strong. Indeed, some of the firms that are prominent employers, producers, and exporters today, such as AES Data Ltd. and Micom Inc., were only started in the 1970's.

Even when the firms are identified, it is often difficult to find out much about them without a good deal of time and effort. As a result, the list of customized producers in Table 3-7 makes no pretense of being complete or accurate. Of greater significance is the characteristics of the firms on the list, and in particular that they tend to be small and Canadian owned and that, while they produce diverse products, many are engaged in terminal production and in some cases intelligent terminal production. Since these products are expected to have significant growth rates in the 1980's, it appears that there is already a number of potential domestic suppliers for this market.

Table 3-7

Representative List of Manufacturers of Customized Computer Hardware and Electronic Office Machines

Company	Ownership	Plant Location	Products
Ahern and Soper Ltd.	Can.	Rexdale, Ont.	Terminals, small business systems, word processing
Canadian Instrumentation Co. Ltd.	Can.	Milton, Ont.	Microfilm viewers
Conterm Ltd.	Can.	Pointe Claire, Que.	Small business systems, terminals, printers
Cremanco Systems Ltd.	Can.	Vancouver, B.C.	Small business systems for the restaurant industry
Cybernex Ltd.	Can.	Ottawa, Ont.	Small business systems, word processing, terminals
Datamex Ltd.	Can.	Toronto, Ont.	Terminals
DGA Electrontics Ltd.	Can.	Toronto, Ont.	Small business systems
Diamco Ltd.	Can.	Calgary, Alta.	Microfilm viewers
Dynalogic Corp. Ltd.	Can.	Ottawa, Ont.	Small business systems, word processing, terminals,disk drives, bubble memory subsystems
Digital Methods Ltd.	Can.	Ottawa, Ont.	Small business systems, graphics
Epic Data Sales Ltd.	Can.	Richmond, B.C.	Small business systems, terminals, data entry

(Table 3-7 continued on next page)

Table 3-7 (continued)

Company	Ownership	Plant Location	Products
Fortin Electronics Corp.	Can.	Winnipeg, Man.	Small business systems, word processing
Geac Computer Corp. Ltd.	Can.	Markham, Ont.	Business systems, word processing, data entry and acquisition systems
Infobox Microsystems Ltd.	Can.	Montreal, Que.	Small business systems, word processing
Innovative Computer Systems Corp.	Can.	Toronto, Ont.	Small business systems, word processing, terminals
International Mobile Data Inc.	Can.	Richmond, B.C.	Terminals (for mobile data technology)
Lanpar Ltd.	Can.	Toronto, Ont.	Small business systems, word processing
Leigh Instruments Ltd.	Can.	Waterloo, Ont.	Optical character readers, printers
Lektromedia Ltd.	Can.	Belleville, Ont.	Graphic systems, terminals
Matrox Electronics Systems Ltd.	Can.	Montreal, Que.	Graphic systems, small business systems, terminals
MCM Computers Ltd.	Can.	Kingston, Ont.	Desktop computers,small business systems, word processing, terminals
McQueen Technology Corp.	Can.	Guelph, Ont.	Small business systems, terminals
Megatel Computer Corp. Inc.	Can.	Toronto, Ont.	Desktop computers, word processing
Microvue Products Ltd.	Can.	Barrie, Ont.	Microfilm viewers
Microfilm Recording Co.Ltd.	Can.	Rexdale, Ont.	Microfilm viewers

(Table 3-7 concluded on next page)

Table 3-7 (concluded)

Company	Ownership	Plant Location	Products
Nakcomm Communications Inc.	Can.	Brampton, Ont.	Small business systems
Norpak Ltd.	Can.	Pakenham, Ont.	Data entry and collections systems, terminals
Patrick Computer Systems Inc.	Can.	Winnipeg, Man.	Small business systems, terminals
Perle Systems Ltd.	Can.	Willowdale, Ont.	Small business systems, data entry and collection systems, graphics, word processing
Société Générale Tortue Ltée.	Can.	Boucherville, Que.	Small business systems, terminals
Transduction Ltd.	Can.	Mississagua, Ont.	Small business systems, graphics
Taltek Electronics Ltd.	Can.	Montreal, Que.	Terminals, desktop computers
Westinghouse Canada Ltd.	U.S.	Burlington, Ont.	Terminals

Source: Dept. of Industry, Trade and Commerce, Canada in the World of Electronics, 5th edition, 1980 and unpublished papers; Canadian Advanced Technology Association, The Catalog, Ottawa, Oct. 1980; Computer Data, Canadian Data Processing Directory 1980, Maclean-Hunter Ltd.,Toronto; Electronics and Communications, Epic 80, Electronic Procurement Index for Canada, Southam Business Publications, Toronto; Evans Research Corp., The EDP Guide, Vol.II; Fraser's Canadian Trade Directory, 1980; Scott's Industrial Directory, 1980.

Given the nature of the supplying firms and of Canadian production, it is clear then that imports are likely to comprise a very large share of domestic consumption. Yet estimating the value of domestic consumption of computers, peripherals, and electronic office machines and the share accounted for by imports from published sources is an extremely difficult task. It was noted in Section 3.1 that many of the establishments producing these products are assigned to SIC 318 and that this SIC industry is often taken as an approximation of the subsector. Unfortunately, it is a poor approximation because SIC 318 also includes establishments producing mechanical and electromechanical equipment and because some products that properly belong in this subsector are produced by establishments assigned to other SIC industries. Moreover, it is not possible to build up independent estimates of the value of shipments for the subsector from individual product shipment data since a good deal of this data is not published to avoid disclosing information on individual establishments. Hence, there is no quick and easy way to measure the value of shipments for this subsector.

The same problems plague the published trade data, and especially the export data. Again, the commodity categories are often not defined properly for our purposes, or if they are, published data may not be shown for the commodity category but assigned to a general "not elsewhere specified" category to avoid disclosing information on individual firms. As a result, it is difficult to obtain the required data on exports and imports as well. With sufficient time and with data from other sources, it might be possible to estimate domestic consumption and imports and exports for the

subsector,but given the limited time available for this study, no attempt will be made to do this in this paper. The best that can be done is to draw on what other estimates are available to try to provide rough measures of what is required.

In the vacuum created by a lack of official published data, one privately produced series by Evans Research Corp. is often used to approximate the required information. The Evans data, reproduced in Table 3-8 for 1979 are estimates of revenue for computer hardware suppliers in Canada. While the estimates are interesting in themselves,they do not provide a measure of Canadian consumption because they include export revenue along with revenue from domestic production and imports. Hence they greatly overstate the value of domestic consumption. Yet the data are useful in pointing out the major suppliers in the Canadian computer hardware market,although one cannot derive estimates of market shares from such data.

Table 3-8

Estimated EDP Revenue of
Suppliers of Hardware in Canada, 1979

Company	EDP Hardware Revenue	
	Amount (Millions of dollars)	Percent of total
IBM Canada Ltd.	896.0	41.6
NCR Canada Ltd.	150.3	7.0
Digital Equipment of Canada Ltd.	119.0	5.5
Control Data Canada Ltd.	118.2	5.5
AES Data Ltd.	113.3	5.3
Sperry Rand Canada Ltd.	109.2	5.1
Burroughs Business Machines Ltd.	76.9	3.6
Honeywell Information Systems Ltd.	74.5	3.5
Phillips Electronics Industries Ltd.	55.5	2.6
Xerox Canada Ltd.	40.8	1.9
Hewlett-Packard (Canada) Ltd.	38.2	1.8
Amdahl Ltd.	32.6	1.5
MAI Canada Ltd.	30.5	1.4
Memorex Canada Ltd.	26.2	1.2
Consolidated Computer Inc.	23.0	1.1
Olivetti Canada Ltd.	22.9	1.1
Mitel Corp.	21.6	1.0
Subtotal (17 companies)	1,948.7	90.5
Total (42 companies)	2,152.8	100.0

Source: Evans' Research Corp., The EDP Guide, Vol. II.

A second source of data on the Canadian market for both computer hardware and office machines is from Canadian Electronics Engineering. Table 3-9 shows these estimates for 1979,which are based on Statistics Canada trade data and on Maclean-Hunter Research Bureau estimates of domestic production net of exports. Canadian consumption is simply imports plus production net of exports, or $1,438 million. However, a quick glance at the trade data shows that both imports and exports are understated because a number of computer and office machine products have not been included and because re-exports have not been removed. It is possible to make some crude adjustments to these estimates to account for some of the missing products but not all of them since many are found in aggregated commodity categories. All the adjustments, which are also shown in Table 3-9 , affect the estimates of imports (net of re-exports) and cause them to rise by about 4% ,from $1,173 million to $1,224 million. As a result ,the estimate of domestic consumption, or better ,the apparent domestic market (ADM), increases from $1,438 million to $1,489 million.

If one accepts the Maclean-Hunter Research Bureau's estimates of production net of exports and recognizes that both imports and exports are still understated, then $1,489 million represents a lower bound estimate of the ADM in 1979. Based on this lower bound estimate, imports would account for at least 82% of the ADM and exports for at least 68% of domestic production. Unfortunately, the estimate of production net of exports appear to be somewhat high,which means that the lower bound estimate is likely smaller

Table 3-9

Canadian Electronic Engineering Estimates of Imports, Exports, and Production Net of Exports, and Adjustments, 1979
(Thousands of Dollars)

Commodity	Imports	Domestic Exports	Production Net of Exports
Canadian Electronic Engineering Estimates			
Computers and Peripherals			
Electronic computers and parts (771-22) (1)	1,102,088		
Card punching, sorting and tabulating machines, and electronic computers, and parts (771-21)		503,979	
Computer tapes (634-78)	8,997		
Subtotal	1,111,085	503,979	125,000
Electronic Office Machines			
Calculating machines and parts (771-15)	56,588		
Carding, punching, sorting and tabulating machines, and parts (771-20)	5,631		
Office machines, equipment and parts nes (771-99) (1)		71,742	
Subtotal	62,219	71,742	140,000
Total	1,173,304	575,721	265,000

(Table 3-9 concluded on next page)

1. Adjusted to conform with data in Statistics Canada, Imports Merchandise Trade, 1979 Cat. No.62-203

Table 3-9 (concluded)

Commodity	Imports	Domestic Exports	Production Net of Exports
Adjustments			
Add Imports			
Typewriters, electronic word processing (771-46)	12,862		
Dictating, transcribing and record obliterating machines, and parts and accessories (771-36)	11,465		
Photocopy and similar machines, office type, and parts (919-47)	171,424		
Microfilm equipment and parts (919-48)	13,557		
Subtract Re-exports			
Card punching, sorting and tabulating machines, and electronic computers, and parts (771-20)	152,223		
Office machines, equipment and parts nes (771-99)	6,463		
Subtotal	50,622		
Adjusted Total	1,223,926	575,721	265,000

Source: Canadian Electronic Engineering, January, 1981 and Statistics Canada, Imports Merchandise Trade, 1979 (Cat. No. 62-203) and Exports Merchandise Trade, 1979 (Cat. No. 65-202)

and the minimum import and export shares are likely greater than the earlier estimates suggest.(1)

The crude data on Canadian consumption and the flows of exports and imports along with the nature of Canadian production leads to a number of implications for the Canadian economy and the industry. One obvious implication is Canada's very large trade deficit in computer and electronic office machine hardware. The problem can be highlighted by restating the trade data for 1979 in a somewhat different form in Table 3-10.

The data in the table show that Canada's trade deficit in hardware was about $648 million in 1979 and that a very large share of this deficit, about $461 million, was accounted for by computers and peripherals. Canadian imports come primarily from the United States and represent the activities of the rationalized multinationals and the branch office suppliers. While the bulk of Canadian exports also go to the United States, our exports show a somewhat more diverse pattern than our imports. This in part represents the activities of the rationalized multinationals,which in some cases have world mandates for their output, but it also represents the activities of Canadian firms,which seem to have a more diversified

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1. A paper prepared by the Electrical and Electronics Branch of Industry, Trade and Commerce on Computers and Office Machines shows considerably larger shares for imports, and especially for exports, but the paper defines the subsector more broadly than in this paper. Since the IT&C study is still in the draft stage, I have refrained from quoting from it.

Table 3-10
Imports, Domestic Exports, Re-Exports, and the Trade Balance
for Computers, Peripherals and Electronic Office Machines, 1979
(Thousands of Dollars)

Commodity Class	Commodity	Imports	Domestic Exports	Re-Exports	Trade Balance
	Computers and Peripherals				
771-22	Electronic computers and parts	1,102,088			
771-21	Card punching, sorting and tabulating machines, and electronic computers, and parts		503,979	152,223	
771-20	Card punching, sorting and tabulating machines, and parts	5,631			
634-78	Computer tapes	8,997			
	Subtotal	1,116,716	503,979	152,223	460,514
	Electronic Office Machines				
771-15	Calculating machines and parts	56,588			
771-36	Dictating, transcribing and record obliterating machines, and parts and accessories	11,465			
771-46	Typewriters, electronic word processing	12,862			
771-99	Office machines, equipment and parts nes		71,742	6,463	
919-47	Photocopy and similar machines, office type, and parts	171,424			
919-48	Microfilm equipment and parts	13,557			
	Subtotal	265,896	71,742	6,463	187,691
	Total	1,382,612	575,721	158,686	648,205

Source: Statistics Canada, Imports Merchandise Trade, 1979 (Cat. No. 62-203) and Exports Merchandise Trade, 1979 (Cat. No. 65-202).

pattern of export sales. Given that both imports and exports are understated, the actual trade deficit may differ from the one shown in the table, yet it is still clear that Canada is a substantial net importer of these commodities and that the bulk of our trade is with the United States.

A second implication that can be derived from the trade data and the nature of Canadian production is that the current tariff is likely of little consequence in protecting Canadian production. Canadian producers are already highly specialized and a very large share of Canadian output is exported. Hence Canadian products appear to be competitive in the markets in which they trade and the proposed reduction in tariffs in the 1980's, by itself, is not likely to have any detrimental effect on Canadian production. On the contrary, it may even stimulate it because the current tariff, while not providing any significant protection for Canadian producers, does serve to constrain imports and domestic consumption. This is especially true for commodities where price sensitivity is high, such as the small computer systems. A reduction in tariffs, therefore, could expand the size of the domestic market for such commodities and this may make it more attractive for Canadian firms to enter or for foreign firms to set up branch plant production.

Even if such optimistic events do not occur and the tariff reductions simply increase imports, the increased productivity that could arise from the spread of computer-based technology is itself a sufficient incentive to stimulate consumption. The point has been made by many observers[1] who argue not only for the complete

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1. Including the Tariff Board; see Report Reference No.150.

elimination of the tariff but also for a removal of the federal sales tax on computers and peripherals. As a result of the Tokyo-round of GATT negotiations, the most favoured nation (MFN) tariff on computers and some peripherals has fallen from 10 percent in 1979 to 7.6 percent in 1981 and will continue to fall to January 1, 1984 when it will reach 3.9 percent. Most peripherals, which were formerly subject to a 15 percent MFN rate, now enter free. Hence Canada has gone a long way in reducing tariffs, but it is clearly in our own interest to get rid of them completely along with the federal sales tax on such equipment.

While the reduction in tariff barriers poses little potential threat to the industry, other changes could have more serious consequences. Technical change is an obvious one and specialized producers who fail to keep up with technical change could find that their products are rendered noncompetitive on domestic and foreign markets. A second obvious change is a possible significant rise in the value of the Canadian dollar relative to the currencies of other producing countries that is not related to changes in relative production costs but to capital inflows such as for major energy projects. While our current exchange rate may not be entirely appropriate given relative production costs, it has been beneficial to Canadian producers,and a rise in the exchange rate because of capital inflows could make it more difficult for Canadian producers to compete on foreign markets. Also, given that a good deal of Canadian production is accounted for by the rationalized multinationals, any decision to shift these firms' production elsewhere could have a significant effect on Canadian production.

All these changes pose serious consequences for the trade balance but a fourth one is often cited as guaranteeing that Canada's trade deficit will widen significantly during the 1980's. It is related to the expected explosive growth in the demand for computers, peripherals,and electronic office machines and the fact that we have few producers of this equipment. While such an outcome is indeed possible as suggested earlier when the removal of tariff barriers was discussed, it is not a necessary outcome. This is in part because existing Canadian producers are likely to share in the growth of the market. Also, Canada has a significant presence in telecommunications and terminal production. Since telecommunications producers appear anxious to participate in the office automation market and since terminal makers could also participate by adding intelligence to their terminals, a number of potential Canadian producers could be viewed as waiting in the wings. Moreover, the falling unskilled and semiskilled labour content and the rising highly skilled labour and capital content means that these commodities are not likely candidates for production in low labour cost countries. Yet, even if we assume the worst and argue that hardware production will become concentrated in the United States,Japan, and possible other countries, there will still be a substantial Canadian presence in the industry and Canadian content in consumption because of software. It is software that makes the intelligent systems work and Canada does seem to have some competitive advantage in the production of software.

3.5 Employment Implications

The discussion will concentrate on the implications from the suppliers'point of view and not on the much debated consequences of automation for office employment. However, to the extent that users demand the same labour skills as suppliers, some comments will apply to both sides of the market. All the implications are based on the trends described earlier or on comments provided by knowledgeable industry observers in interviews.

Computer and peripheral manufacturers and other industry experts confirm what is already obvious from even a casual glance at the employment ads in major newspapers -- there is a critical shortage of computer support personnel (systems analysts, programmers, and to a lesser extent, operating systems personnel). I have been told, but cannot confirm, that not only have salaries been rising at a much faster rate than the average but that job classifications have also been changing and pushing up the effective salaries even more. Since these types of skills are required by hardware vendors, computer service bureaus, telecommunications manufacturers and carriers, and computer systems users, among others, the shortage affects the whole electronics industry. It has also been argued convincingly that the labour shortages have significantly slowed down the spread of computer based technology in Canada and that they will continue to do so until technical change begins to offset rising software costs. The problem, however, is not unique to Canada and in fact plagues all developed countries.

It has already been noted that some technical changes are expected to occur in the 1980's which should ease the problem to some extent. In the case of operating systems personnel, the increased reliability of mainframes has reduced the downtime and begun to slow down the growth in demand. It is possible that the later 1980's may even see an absolute drop in the demand for this type of labour despite a projected increase in the number of mainframes in use. Technical change should also help ease the shortage of general systems analysts and programmers as programmable chips permit software to become embodied in hardware and other technical changes occur that allow people with few programming skills to use the machines. Nevertheless, the sheer growth in the use of computers will continue to create pressure on supply even as the number of workers grows. Of greater significance is the expected severe shortage of general applications personnel -- people who understand software and who also understand the applications to which the software is to be put. Everyone interviewed pointed out that a shortage of this type of skill will place a major constraint on the continued spread of computer based technology during the decade.

Some concern was expressed about the problem of recruiting hardware design personnel such as mechanical and electrical engineers. Yet the more common view was that these skills are not really in short supply. Universities appear to be turning out adequate numbers and capable students are being attracted to these professions since they seem to offer "glamour-type" jobs after graduation. Of greater concern in hardware manufacturing are the technicians and technologists, the personnel involved in turning

the applied research into marketable products. The general view was that it was difficult to recruit them and some firms have responded by stockpiling personnel and by recruiting graduates of private technical schools and upgrading their training on the job. Given the expected growth in the volume of electronics products, it is both possible and likely that these skills, along with the applications software skills, will be the major areas of shortage over the next ten years.

Little concern was expressed about an actual or potential shortage of labour in the assembling of hardware. Indeed, because of the spread of microelectronic technology, most observers expect that the labour content in assembling will decline as the chip continues to replace the circuit board. Hence, in spite of the projected growth in output, few observers expect assembly labour to pose a constraint on future growth.

The final area of concern involves the maintenance and repair of the hardware. In the case of mainframe computer systems, repair and maintenance is becoming simplified through on-line monitoring. While the diagnostic skills required of the monitoring personnel will rise sharply, few will be required. However, the number and the skill level of the field staff should drop because of centralized direction and the increased reliability of the hardware. The opposite trend appears likely for small computer systems and the computerized office machines. Given the large growth in this type of hardware, one would expect that many field repair technicians will be required and at present there appears to be a shortage of this type of labour skill. However, it is

possible that some of the required labour may come from surpluses in other areas. An interesting example of this is the case of a television manufacturer that faced excess capacity in its service operations because of the increased reliability of home TV sets. By upgrading labour skills, the firm has begun to use its excess capacity in computer system maintenance contracts.

4. Concluding Comments

4.1 Summary of Findings

The primary purpose of this paper has been to set out an approach to manpower forecasting rather than to provide definitive projections of the labour requirements for the electronics industry. Nevertheless, certain conclusions arise from the two subsectors examined.

Among the consumer products discussed, it is obvious that some (video cassette recorders, video cameras, and videodisc players) are not likely to be produced in Canada and that others, which are or will be produced here (TV receivers, projection TV, satellite-to-home antenna systems, and microwave ovens) have labour requirements that appear to pose no constraint on production. Making judgments about the remaining consumer product examined (home information systems) is difficult since it is not yet clear whether these systems will catch on, and if they do, how quickly the market will develop. Moreover, the important question of whether the Canadian Telidon technology will be accepted in the U.S. market, or whether it will even be used in Canada, cannot yet be answered.

Given the uncertainty, the best that can be done is to state that jobs could be generated in the production of hardware for the domestic market, and possibly the export market, and that the labour constraints on production appear to be similar to those for the computer, peripheral and electronic office machines subsector summarized below. Furthermore, since these systems are computer based, they require computer software skills that are expected to be in particularly short supply in the 1980's. The most significant employment opportunities in consumer products, however, do not lie in the manufacturing of hardware but in the production of programming and the generation of data bases for home entertainment, education, and information systems and for industrial and commercial applications.

All industry observers agreed that the market for computers, peripherals, and electronic office machines will grow rapidly in the 1980's although there is some disagreement as to how quickly companies will implement the office of the future technology. The current constraint on the spread of computer based technology is a critical shortage of software personnel--programmers, systems analysts, and applications analysts. Technical change, in the form of program automation, programmable chips, and possibly the introduction of nonprocedural languages and voice synthesizer technology, may help mitigate the pressures on the supply of programmers and systems analysts by the late 1980's. But a shortage of applications personnel, the people who understand software and the applications to which the computer will be put, will be a continuing difficulty.

In hardware manufacturing, a shortage of technologists and technicians, the personnel who turn the applied research into marketable products, is the current constraint on production rather than design engineers or assembly labour. This is expected to continue as the chip increases the skilled labour and capital content of production and reduces the assembly labour content. Finally, the sheer growth in the use of computer systems, and especially small systems, should accentuate the current shortage of maintenance and repair personnel despite the fact that electronic hardware is becoming increasingly more reliable.

The current shortage of software personnel is not unique to Canada but plagues all countries that are applying computer based technology. Indeed, the impression conveyed in interviews is that Canada seems somewhat better off than other countries, especially the United States, where the shortage is even more of a problem. As computer based technology spreads to more and more applications, many opportunities will arise and an adequate supply of software skills could bestow certain advantages on Canada. First, it will permit Canada to supply the growing domestic market for software as well as to tap export

markets where output may be constrained by labour shortages. Second, it may encourage the expansion of domestically owned hardware manufacturers since users are becoming increasingly concerned about the availability and quality of the software for the systems they buy. Third, because of the increasing software content in the design and production of hardware, the availability of software personnel is becoming more and more the crucial determinant of the location of production. Hence, adequate supplies of trained personnel could make Canada attractive as a location for multinational hardware producers and for the software required to operate their systems. Finally, the availability of software skills is also of concern to other industries as they apply computer based technology to their production processes and to the information flows required to carry out their activities.

4.2 Forecasting Manpower Requirements for the Industry

The implications for employment and the likely constraints on output imposed by a shortage of skilled labour discussed in this paper are qualitative rather than quantitative forecasts. They are based on an attempt to set out a consensus view of the likely trends over the rest of the decade obtained from interviews with knowledgeable industry observers and from information derived from secondary sources. Thus the forecasts embody a set of expectations about the growth of demand in the product markets and the implications that this has for the demand for labour. They also include a set of expectations on how technical change may alter the mix of skills in production and what the skill mix may be for products not yet on the market. Finally, they include an implicit set of assumptions as to how the supply of particular labour skills will change and how the wage rates for these skills are likely to adjust over the period.

The forecasted shortages suggest that the product output expectations are not likely to be realized unless the supply of skilled labour required to accommodate it grows more quickly than anticipated. This is because wage rates will rise more quickly than anticipated and crowd out some of the expected output. It is in this sense that the supply of skilled labour poses a constraint on output and not because a gap will develop between the expected demand for labour and the anticipated supply.

To some extent the expected constraints on output are overstated because observers tacitly assume that the supply curves for the required labour skills are perfectly inelastic. Yet market behaviour and the responses of the companies themselves indicate that supply is not unresponsive to changes in the wage rates. In the market for programming skills, the rising wage rates have led to a considerable number of part-time workers being enticed into the market. One

estimate for the United States puts the number of part-time workers at half the 600,000 people employed as programmers.[1] Accommodations are also made for people who wish to work as programmers but who are unable to participate in the usual manner. In the United Kingdom, F International Ltd. employs part-time female labour with programming skills by providing terminals so that they can produce software at home.[2] Yet despite these observations, the forecasted constraints on output are likely still valid.

It is possible, but much more difficult, to convert the qualitative forecasts into quantitative forecasts. This would involve the same collection of intelligence at the micro level on product market trends, on the competitive environment both domestically and internationally, and on technical change in order to estimate product demand and the impact that technical change might have in creating new products and altering the skill mix in production.

The product demand forecasts could then be converted into a set of labour demand forecasts by skill if current technical coefficients are available. Such data may become available as a result of a study being undertaken by the Ontario Manpower Commission for the Ontario Task Force on Microelectronics. The study involves a survey of electronic hardware manufacturers, software producers, and data processing service bureaus to obtain current employment data by skill and the companies' forecasts of expected employment by skill for the period up to 1985. The survey should permit the required current technical coefficients to be obtained and they could then be used along with independently derived product demand forecasts to produce short-term manpower forecasts. By adjusting the coefficients for the expected technical changes in production, longer term forecasts can be obtained as well. A set of labour

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1. "Missing Computer Software", Business Week, September 1, 1980.

2. "The Potential for Telecommuting", Business Week, January 26, 1981.

supply forecasts by skill can then be derived in the conventional manner by extrapolating the current estimated supply into the future on the basis of anticipated additions and retirements. Given the estimates of labour demand and labour supply, it is then possible to produce quantitative estimates of the constraints that the forecasted labour supply may impose on production.

4.3 Gathering the Intelligence

A micro approach to manpower forecasting requires the gathering of substantial amounts of information and the personnel to analyze and evaluate it. A good deal of the required information for the electronics industry is already being gathered by different units of government. In preparing this paper, interviews were conducted with officials in federal government departments and in some provincial government departments as well and I was struck with the large number of studies being undertaken on different aspects of the electronics industry and the "microelectronic revolution" in general.

A number of studies are being undertaken at the federal level by the Department of Communications, the Ministry of State for Science and Technology, and the Department of Industry, Trade and Commerce. However, studies are also being prepared by the Department of Labour, the Department of Regional Economic Expansion, the Ministry of State for Economic Development, and the Secretary of State, and I am sure that this is only a short list. In addition there is a major Ontario government task force on microelectronics and other provinces are also studying the industry.

While there is some cooperation among the units undertaking these studies, many are being done in a vacuum. More importantly, opportunities are often examined without considering whether the labour required to support them will actually be available, or better, whether the required labour may be at the expense of some other identified opportunity. There is a need, therefore, for manpower forecasting to become part of this process so that manpower planning can be used to help facilitate the identified opportunities. How this is to be done is an organizational question beyond the terms of reference of this study. Yet it is clear that some mechanism is required to bring manpower forecasting and manpower planning into the process of identifying opportunities.